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An Analysis of Soft Skills Development of A Formula-Student (SAE) Team*

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Formula Student (also known as Formula SAE) is an international competition for universities that challenges the students with a comprehensive engineering problem. Most of the participant universities and all the companies involved in the organization of the competition have identified this event as the most suitable tool for hard and soft skills development. This paper evaluates this development by means of two different objective assessments in the frame of a specific team, identifying the potential of the competition and showing a particular approach to enhance soft skills development.

Keywords: soft skills; scoring rubric; E-Delphi; Formula Student; practical case study

1. Introduction

At present, technical and non-technical (soft) skills are considered equally important by employers who are searching for professional engineers: the employers are continuously demanding engineering graduates with good technical and analytical skills, but with good development of interpersonal and soft skills in general [1] These soft skills, such as teamwork, interpersonal communication, public speaking, conflict management and others, are hardly covered in regular lectures. Therefore, they have traditionally been developed just through laboratory work and the master thesis, but in an arbitrary way. Moreover, in most cases, those are projects with predetermined outcomes and very specific formulations. This is in agreement with the French educational model developed in the late 18th century and that was inherited or adopted by most of the Engineering Schools.

However, Open European Higher Education Area, as part of the Bologna Process [2], fosters an active teaching model where the student is not a passive receptor but an active participant. Considering the new scenario proposed by the Bologna Process and also the importance of soft skills development during college years, lots of effort have been made by the educational community to develop case studies of educational projects that foster student learning. Some of those studies can be found in the scientific literature: many of them are based on a case study methodology [3] and others are project-based learning cases [4], most of which belong to the broader case type of problem-based learning [5]. These approaches help the student to have a closer look at real work, but the fact remains that these projects do not constitute real work, and therefore are not the more indicated tool for soft skills development.

Formula Student (FS) or Formula SAE (Society of Automotive Engineers) is a group of international competitions for Universities which challenges the students to design and manufacture a single seater racing car that they will have to set up, test and compete with. This competition fosters technical knowledge and excellence, but also soft skills development, by facing students with a complete real life hands-on project.

The competition is not only focused on determining which is the fastest car, or which car gets the shortest time to complete a given circuit: is focused on finding the most complete car and the most complete team.

To do so, the competition is split into two different parts: static events and dynamic events. The static events comprise evaluation of the car's design and concept, an exhaustive cost analysis of the whole car and a business plan for a hypothetical launch of the car to the market.

The dynamic events are 5 different tests used to evaluate the acceleration, the handling, the reliability and the fuel consumption of the cars.

Taking all of this into account, FS competition is a great opportunity for educators from engineering schools to establish a methodology for the development of soft skills in a real work environment. This has been acknowledged by the educators and the academic community and there are already some publications regarding the FS strengths.

Generally speaking, the benefits from FS in soft skills development are recognised and accepted: studies like those from Kennedy and Wheway [6]

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highlights the incorporation of leadership, teamwork and project management into the students' curriculum, providing them with an invaluable preparation for work after graduation. A similar study was carried out by Anderson et al. [7] identifying some other soft skills like critical thinking and problem solving. Gerbus et al. [8] even compared the education and development of regular students with that of students that participate in this kind of competitions. The study revealed that, although FS being a time-consuming activity, taking part in the FS project effectively improves technical knowledge and understanding without interfering in the normal coursework, apart from developing soft skills.

Trying to take out the most from Moto-Student (an educational competition similar to Formula Student), Fernández del Rincón et al. [9] propose a methodology to incorporate this sort of projects into the academic program; and in the case of Simpson et al. [10], they find that the benefits form the FS project could be higher by spending more time in product development and industrialization, proposing some changes and improvements. FS has also been analysed from different perspectives. Bischof et al. analyse in [11] the impact of the Formula Student competition on students' choice of undergraduate research projects. The main conclusion drawn is that their involvement in a real project enhances their creativity and motivation towards research. Another example of FS as a real platform is the work of Akbar and Jafar Jamshidi in [12], where they propose using the structure of an FS project for the implementation of a Product Lifecycle Management (PLM) strategy.

However, any of the previous cited studies carried out a proper assessment to evaluate the degree of development of soft skills inside a Formula Student team. That is also the case of Leyssens et al. [13], where all the benefits forma Formula Student are outlined, but not assessed. A similar study was carried out by Akop et al. [14], but they propose the assessment of soft skills development as a future line of research. Buchal et al. [15] propose the same work, as they identify the potentiality of FS but find interesting a good assessment to evaluate if the students are taking out the most from the project. Some studies like those of O'Doherty [16] and Sánchez-Alejo et al. [17] do already undertake some kind of assessment. However, in the case of [16] is restricted to the teamwork ability, and in the case of [17] the students go through a survey to determine the importance of different soft skills in FS, but they do not assess the development of each skill from different perspectives. It is also important to highlight that the study in [17] is not restricted to Formula Student, but covers some other competitions like Eco-Shell Marathon.

As inferred from the previous paragraphs, there is general consensus about the potential impact of the Formula Student Competition on the generation of non-technical skills but a proper assessment should be carried out to validate that potential and to evaluate to which extend soft skills are fostered in a real Formula Student team. In this way, this is the aim of this manuscript: to define and assess soft skills development in FS, establishing the importance of each skill in the project, but also evaluating the level of performance of every skill from different perspectives. This study is done by means of two well-established assessment methods, like E-Delphy and Scoring Rubrics; and is done in the frame of a Formula Student team: TECNUN Formula Student.

2. A specific approach to Formula Student

TECNUN Formula Student (TFS) is a group of students at TECNUN (the University of Navarra's School of Engineering) that has the objective of designing and manufacturing from scratch two racing cars (an internal combustion engine and an electric car) to compete in at least two different FS events. This group was created in 2008 and in the five years since it and has built 8 racing cars.

During these years the group has seen that, far from being a competition focused exclusively on technical knowledge and innovation, FS also requires such diverse things like media coverage, the creation of a business plan, fund raising, the development of a corporate image, etc., which makes FS the ideal environment for developing soft skills. Considering this, TFS has been specially structured to foster soft skills development, making the most of the FS competition.

TFS has established three main objectives:

1. Technical excellence for every project: This objective is mainly related to the performance of the cars in competition, and assessment is provided by the competition itself.
2. Technical excellence for every student: As a platform for project-based learning, it is crucial that the students learn technical competences related to their specific job. Once again, assessment is provided by the competition.
3. Excellence in non-technical skills: this objective mainly deals with working, acting, communicating and competing as a high-performance team, where students seek self-development within an organization. The assessment of this objective comes from the competition results as well as the survey done every year based on the E-Delphi method and the scoring rubric method. In this aspect, the most interesting

and gratifying information comes in the medium-long term, from the alumni that left us several years ago and work in real projects in the industry.

From a technical point of view, TFS has an organizational structure that is similar to any automotive R&D department. The students are divided into working areas inside a matrix organization, so that the horizontal flow of skills and information is facilitated. There are three main areas: mechanical, electronic and management, shared for the most part by both projects: the internal combustion project and the electric project. The main structure can be seen in Fig. 1.

For every car there is a Project Manager, who is responsible for the design and manufacturing of the car, and the mechanical, electronic and management areas each has an Area Manager, who is responsible for the assignment and fulfillment of the tasks.

The communication between the members of the team is assured by a set of meetings across three levels. At the lower level are the "task meetings" that are held with the students involved in a particular task and convened by the managers to assure the fulfilment of the targets related to objective 1 above.

At a higher level there are "learning meetings", held between the students and a supervising professor at Tecnun. These professors are not directly involved in the TFS project, but they serve as supervisor for one of the knowledge areas in Fig. 1. At the "learning meetings" they give lectures on the area of expertise that is relevant to the knowledge area. They are responsible for detecting the skills the students need to have, be they technical or non-technical. Thus, the main goal of this supervision is to achieve technical excellence in the students' learning process (objective 2) as well as to develop the soft skills needed by every team member so the team is able to act together in excellence (objective 3).

Finally, there is a weekly meeting between the managers and the faculty advisors just to assure that the team's strategy is following the correct path and to determine the measures that need to be taken if something is not working properly.

Although TFS is a Spanish team, the official language is English. It is mandatory to conduct all the meetings in this language so that the students learn to communicate effectively. In order to enhance this policy, the two Project Managers are foreigners (i.e. non-Spanish), so communication in English is even more natural among team members.

This TFS structure is oriented toward coping with the challenges that come from students' academic and personal diversity.

3. A methodology for soft skills development

Given the previous sections, it is clear that Formula Student has invaluable potential for developing soft skills due to its inherent competitive, international, multidisciplinary and real-case nature: most of the imaginable soft skills can be developed in an effective way. With the aim of simplifying this study and in order to focus on the most important issues, the authors conducted an electronic survey to identify the top-ten soft skills in Formula Student: the ones that are most fostered and exercised in the project. This was done following the E-Delphi method.

3.1 E-Delphi method

The E-Delphi method is a method used for consensus building. Its main objective is to have a group process that at the same time avoids peer pressure and group influence. A formal definition of the Delphi method was formulated in [18]:

> "Delphi is a method for the systematic solicitation and collection of judgments on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of opinions derived from earlier responses"

This method is an iterative process which alternates a round of questions with compilations and summaries of the obtained answers until consensus is achieved. Its structure may be outlined as follows:

Round 1. As a first step, an open-ended questionnaire is given to the participants. The responses are used by the researchers to create a well-structured questionnaire which will be used in the second round.

Round 2. Each participant receives the well-structured questionnaire prepared in round 1 and is asked to review the items and to rate or rank order items to establish preliminary priorities among

	Mechanical Area				Electrionic Area				Management Area			
	Chassis	Suspension	Combustion Engine	...	Electric Motors	Control	DAQ	...	Internal Management	Sponsors	Supliers	...
Electric Vehicle	x	x			x	x	x		x	x	x	
Combustion Vehicle	x	x	x			x	x		x	x	x	

Fig. 1. Team structure.

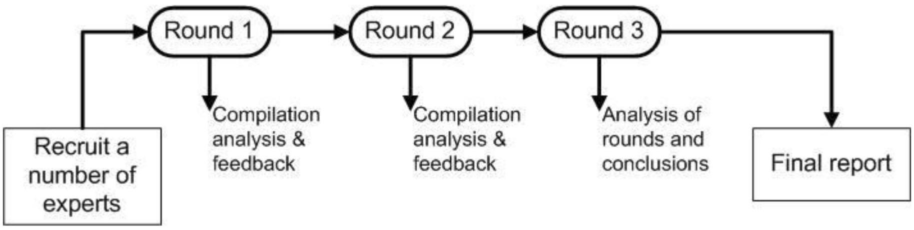

Fig. 2. Schematic representation of the E-Delphi method.

them. This is done with the aim of defining areas of agreement and disagreement. There are different criteria that establish whether consensus has been achieved or not, and the one used in this particular study will be outlined later.

Round 3. Participantsreceive a questionnaire that includes the items and ratings summarized by the researchers in the previous round, and they are asked to revise their judgments or to specify their reasoning if they remain outside the consensus. This round gives the researchers an opportunity to make further clarifications about both the information and their judgments about the relative importance of the items.

Round 4. In the last stage, the list of remaining items, their ratings, minority opinions, and items achieving consensus are distributed to all the team members.

3.2 Results

For this study the E-Delphi was administered by means of an electronic survey conducted with the team members. Thirty-four team members participated in the survey, which constitutes 65% of the current team members. This population was found to be representative enough for the present study. Team members had to evaluate, based on their participation in Formula Student, the development and practice of 25 different soft skills on a five-point scale. The criterion established for a soft skill to have group agreement was that at least 70% of votes had to fall within two scores or categories (between 1 and 2 or 3 and 4 and so on) on the five-point scale, and the mean had to be 3.75 or higher. In the present study two iterations were needed to achieve consensus. Slight changes were made to the survey form iteration 1 to iteration 2, as it was observed that the participants found three main problems, which may be outlined as:

- They did not fully understand some of the skills
- They identified some of the skills as being the same
- They missed some skills in the first survey

In this way, 'Time Management' and 'Personal Planning', which were presented as different skills in the first survey, both obtained a percentage below the established criteria for group consensus. However, after feedback was given by the authors and some clarifications were made, both skills were presented as a single one under the name of 'Time Management'. In this case, that soft skill achieved the required group consensus. A similar issue arose between 'Conflict Management' and 'Change Management' and between 'Adaptability' and' Out-of-the-box thinking'.

After changes were made, the results of the final round are depicted in Table 1.

The results show group agreement on the most fostered soft skills in Formula Student. The table displays the soft skills in descending order of importance according to group consensus, and only the

Table 1. Mean and percentage of votes in the two maximum categories for the soft skills studied using the E-Delphi method

Soft Skill	Mean Scale 1–5	% votes in categories 3 & 4	Soft Skill	Mean Scale 1–5	% votes in categories 3 & 4
TeamWork	4.7	96%	Entrepreneurship	3.6	59%
Will Power	4.49	93%	Emotional control	3.6	58%
Out-of-the-box Thinking	4.3	83%	Analytic Thinking	3.5	55%
Conflict Management	4.15	83%	Power of Persuasion	3.4	53%
Decision Making	4.1	80%	Self-motivation	3.5	53%
Optimism	4	80%	Negotiation Skills	3.2	52%
Information Management	3.8	77%	Meticulousness	3.4	50%
Resource Management	4	75%	Resilience	3.4	50%
Time Management	3.78	70%	Work Under Pressure	3.2	45%
Leadership	3.9	70%	Social Commitment	3.2	40%
Empathy	3.9	65%	Ethics	3.1	33%
Written Expression	3.5	61%	Customer Orientation	2.8	24%
Oral expression	3.5	60%			

highlighted soft skills reached the established criterion for group agreement. Looking more closely at those ten skills, a wide variety of abilities are tackled in the project, and most of them coincide with those demanded from industry [19]. It is also important to highlight that, apart from those ten skills with group consensus; most of the remaining skills also received a fairly significant rating, indicating that they are also present during project development.

The study carried out in this paper focuses on the ten most representative skills according to the results of the survey. These 10 skills (hereafter the top-ten skills) are detailed in section 4, with a brief description of how the project helps to develop them.

4. The top-ten soft skills in Formula Student

When analysing the Formula Student project from the perspective of soft skills development, it can be split into two different stages: the preparation period and the competition period. Each of these stages has special features, each exerting a different influence on the education of the students. Considering this, each stage will be independently reviewed here, outlining its peculiarities and identifying the most remarkable contributions to soft skills development.

4.1 Preparation period

This stage covers the vast majority of the project, which covers a 360-day period. The Preparation Period has been identified as the part of the project that covers the concept design, the mechanical and technical design of the vehicle, the manufacturing process and the on-track testing, as well as all the management, financial and media coverage related to those tasks. In other words, it covers all the work that has to be done in order to have a competitive team and a competitive single seater car ready for a Formula Student event. To accomplish this, the following tasks are tackled:

- Generating the general vehicle concept.
- Identifying the main technical and team challenges.
- Recruiting the team members.
- Fully planning every single task.
- Creating the different groups and sub-teams: Assigning collective and individual tasks.
- Fulfilling all of the established tasks: weekly group meetings for each sub-team.
- Monitoring the different tasks.
- Bringing all the designs together.
- Manufacturing the vehicle: creating drawings and bills-of-materials to manufacture every single part of the vehicle. Finding the proper manufacturing technology and supplier.
- Assembling the whole car.
- Validating and tuning the car by means of track testing.
- Continuously searching for sponsors and financial support.
- Handling media coverage and continuously updating the different teams' social networks.

It is beyond the scope of this study to go into those tasks in detail, but the list provides an overview of the scale of the project, and it gives a hint about the variety of soft skills that can be developed. Among the top-ten soft skills identified in section 3, the following are particularly fostered in this period.

4.1.1 Decision making

Formula Student is an open exercise that presents students with a practical engineering problem and challenges them to use their own resources and choose among multiple approaches or ways to carry out the task. This is a far cry from regular theory and practical lectures, where the wording and calculation of the subject is perfectly defined and set. Although Formula Student is governed by a rules compendium, most of the rules are safety oriented, enabling and promoting the free design of the car's concept and subsystems. For example, the teams are allowed to compete with an internal combustion engine or with an all-electric car. This spirit of open design mimics the automotive field, where the problem of vehicle design does not have a unique or optimal solution. This then forces designers to choose a path and then make the various decisions that are required, looking for correct trade-offs according to their best judgment. Therefore, students involved in the FS project are constantly challenged to make decisions, to be held accountable for those decisions and to work in a way that is consistent with those decisions.

4.1.2 Teamwork

As explained earlier in section 2, TFS is made up of over 50 students, who are distributed in different sub-groups among three departments. Each sub-group is composed of around 4 students, and they have to work on a specific area of the car. Solving that specific issue already demands and promotes the ability to engage in teamwork: the four students are responsible for their area and they have complete freedom to manage the tasks. These four-students sub-groups are asked to have regular weekly meetings to assure that they are heading in the right direction. Apart from this, each sub-group cannot work independently of the rest of the sub-groups because the design, solution or decision of one group will dramatically affect some other sub-groups: they are all working on the same vehicle, and all their solutions and designs will have to be held by the same chassis. There are other aspects that make the development of the 'teamwork' skill even more interesting in TFS: it is a multidisciplinary project where the work is done by students from different degree programmes, who are at different stages of their degree, and who have different backgrounds. This means that although they all have different expertise, different academic timetables and different points of view, they all have to work together.

4.1.3 Information management

Formula Student is a cyclic project: a typical student will join the TFS team during the third year of his degree, spend two years on the team gaining knowledge, experience, taking on greater responsibilities over time, and eventually he will leave the team, taking with him all his know-how. However, the team has to evolve continuously and improve year by year, and this has to be reflected in the vehicle's design. In trying to minimize the fact that every year the more experienced and skilful team members leave, the students have to document all the work they do—the technical knowledge associated with their work, information about suppliers and manufacturing process, the digital data generated, etc.—so that it can be transferred to future team members. In order to tackle this issue, TFS has also created a 'back-up': a first year team member who works shoulder to shoulder with a final-year member to facilitate the transfer of knowledge.

4.1.4 Time management

One of the main characteristics of this stage is that the students are not exclusively dedicated to the project: they also have to deal with their regular degree requirements and also keep an eye on other important extra academic activities, like learning a second language. At TECNUN, the students' formal education takes up the vast majority of the week, with mandatory lectures in the morning every day and formal practical lectures in the afternoon at least two days out of five. Considering the responsibilities and work that the students have to face as part of the Formula Student project, the only way to juggle the project with their classes is by means of excellent time management skills.

4.1.5 Conflict management

Every sub-system of a vehicle is interrelated with another, and sometimes this means that the obvious solution for one sub-system is not feasible because of the consequences it may have on other systems. For instance, the suspension pick-up points may have an optimal position for the wheels' camber angles, but those positions may be detrimental to chassis stiffness. Situations like this are very common during the design process and must be properly dealt with by the students, who have to try to solve the conflicts without affecting the dynamic of the group and the final result.

4.1.6 Resource management

Time, money and available machinery are common key and limited parameters in any project. FS is no exception, and all the team members must be aware of them and bear them in mind when designing a part, choosing a material or manufacturing process, or establishing priorities.

4.1.7 Assertiveness and willpower

None of the TFS team members have any particular training in the automotive field, which means they all have to tackle problems in an unfamiliar environment or with an unfamiliar application. As they face these sorts of problems and find out they have the ability to solve them, their assertiveness is fostered and developed. Considering this and the large number of hurdles the students have to dodge throughout the project, like dealing with their regular classwork, managing changes, and so on, a big dose of willpower is very helpful.

4.1.8 Leadership

In a normal weekday, the work that can be done is very limited. Therefore, in TFS, it is usual to work during weekends and during vacation periods. This is not easy, and it is important to have a high dose of motivation and passion. For this reason the role of the team leader is very important. A leader makes each member of the team another leader, a person that has the responsibility to carry out a small task, a person that realizes that their small task is part of something larger, and a small task that cannot be delayed because it may delay others. This requires motivation, to be a group not only inside but also outside the workshop.

4.2 Competition period

The competition period does not start on the day that the team arrives at the circuit; a huge amount of work is done in weeks prior to the competition. The technical part of the project is not the only area the team has to focus on: the organizational part of the competition has as much importance as the technical aspects. So much work has to be done in preparing the car in order to meet the competition requirements, but the team also has to focus on arranging for a large number of team members to be present at the circuit. It's not an easy task, but that's where the diversity of profiles and skills among the team members helps to achieve the goal in this project. In this way, a huge number of soft skills are also tackled during the competition period. Some of those skills are also fostered during the preparation period, but they are developed in a different way here.

4.2.1 Teamwork and Leadership

The team is divided into different categories during the competition. Although each follows a very different approach, all are equally critical. There are three main groups in the technical area.

- Team Tech 1: This is composed of the core team members who are responsible for important areas of the car. Their main task is to be the leaders in their respective areas as well as being the ones who take the final decision when a problem appears during the competition days. Their experience from previous years and competitions gives them the responsibility of leading the team in their area in order to meet the established target.
- Team Tech 2: This is mainly formed by junior team members who have the excitement and passion to act upon the decisions of their leader. Because they are the future of the team, communication and teamwork between the two tech groups is crucial in order to achieve the final result and set a good base for future years.
- Team Camp: This team is not focused 100% of the time on the technical side of the competition; its main concern is the organizational area of the competition. They are in charge of things like shopping for missing items, organizing the team's campsite during competition as well as many other tasks or issues that cannot be put aside. Working for the team could be the best way to define this group.

4.2.2 Decision making

When preparing for competition, all teams face a series of important decisions: they have to establish the setting of the whole car for the different dynamic events, set the strategy for those events, nominate the drivers, decide when to compete depending on the weather forecast, etc. All those aspects are great exercises in decision making. However, unforeseen events are very likely to occur in the tough and comprehensive FS competitions. These unforeseen events are a menace to the team's plan, and they force the team to look for alternatives and make decisions under high pressure and with no time for hesitation.

4.2.3 Out-of-the-box thinking

Unforeseen events can arise at any moment, from a structural problem in the vehicle that does not meet the rules to a failure or a breakdown of a vehicle's part during the competition and that must be fixed in order to keep competing. This involves the necessity of making changes to designs, concepts and parts, being able to think of alternative original solutions that can be done with the available resources and with a minimum effect on other areas.

4.2.4 Optimism

Unforeseen events come into play again in this skill. Every unforeseen event threatens not only the team's plans but also all the work done during the whole season. To face those problems it is extremely important to have a high dose of optimism and to keep the team motivated at all times. Moreover, the competition lasts for three days and has three different stages, so it is important to maintain the attitude of optimism no matter what happens along the way. Regardless of whether the team has been successful during the previous stages or not, everyone has to work and be as dedicated as they were during the first minute of the competition.

Because of the diversity of developable skills that new members bring to the team, the authors consider it important to highlight that an analysis of each member is done to identify the strengths of each individual. Therefore, the areas in which each member feels most comfortable and the skills he wants to/can develop are analysed for the team's benefit.

5. Student assessment: the scoring rubric

The team's general thinking about which soft skills are more important was obtained in section 3 using the E-Delphi method. However, this section tries to go one step further and carries out a student assessment to gather a more individual and detailed evaluation from every single team member in order to analyse different aspects of the top-ten skills. With this purpose in mind, a new survey was handed out to the team members following the rubric methodology.

Rubrics are formally defined as "scoring guides, consisting of specific pre-established performance criteria, used in evaluating student's work on performance assessments" [20]. Rubrics articulate the expectations for an assignment by listing the assessment criteria and by describing the levels of quality in relation to each of these criteria [21]. Beyond this, with the main characteristic of scoring rubrics being that they are suitable methods for assessing performance, several studies show that they are also interesting instruments for supporting students' training and their progress.

Scoring rubrics are criterion-referenced methods, where a student's aptitude on a task is evaluated by matching the student's performance against a set of criteria.

Rubrics have three main components:

- Criteria: these are used to establish the characteristics of good performance on a task.
- Levels of performance: these determine the degree to which the student has met the criteria
- Descriptors: these are used to standardize what is expected at each level of performance for each criterion.

An analytic rubric articulates levels of performance for each criterion so the teacher can assess student performance on each criterion, and it is used if the aim is to assess each criterion separately, particularly for assignments that involve a larger number of criteria.

5.1 Results

The number of participants in this survey is again 65% of the team members. The analytic rubric has 2 to 6 questions for different aspects of each of the top-ten skills, and four levels of quality were described for each question, with level 1 being poor development of the tested skill, and level 4 being excellent development. The results obtained for each skill are gathered in a column chart represented in Fig. 3, where each column depicts the percentage of votes for the four quality levels established, and the weighted mean for each question is shown below the column.

The results support the following analysis:

- 'Time Management', 'Teamwork', 'Optimism', 'Will Power' and 'Conflict Management': All these skills have been developed and practiced by the students in an outstanding manner. All of them achieved a weighted mean of 3.25 or more on a four-point scale. This means that these soft skills have not only been identified as crucial in the Formula Student project, but they have also been properly fostered during the project.
- 'Resource Management': In this case, the second question makes reference to the correct use of manufacturing processes and their optimization. For that question, quality levels 3 and 4 obtained a representative number of votes, which represents a great development of the skill. This may seem inconsistent with level 1 showing a somewhat large percentage of votes. However, a close analysis of the results shows that those votes for level 1 are from team members that were not involved in the manufacturing process.
- A similar thing happens with 'Leadership'. Although this skill was very highly considered by the participants in the E-Delphi method, not all the team members play a role that is suitable for developing leadership skills. This has been identified as the reason why quality level 1 has a non-trivial percentage of votes, thereby considerably reducing the weighted mean of the soft skill. Considering this, a more detailed analysis would give more importance to the votes for quality levels 3 and 4: participants who have the chance to practice leadership get the most from the opportunity.
- 'Decision Making' and 'Out-of-the-box Thinking': With a weighted mean slightly above 3 on a four-point scale, both skills are clearly fostered properly, although a representative amount of votes falls within categories 2 and 1, showing that some improvement can be done in those areas.
- 'Information Management': This soft skill achieved a remarkable mean value in the E-Delphi survey, with 77% of the votes within the 2 highest scores or categories. However, the development or the improvement of this soft skill has been shown to be really low, with a weighted mean of 2.66 in the scoring rubric. It is also striking that such a low percentage of the votes are for quality level 4. This denotes something that was later verified by the authors through several meetings with the team members: information management is crucial in the project, but it is not being properly tackled by the TFS team.

6. TECNUN engineering works

We were very interested in contacting former TFS team leaders, not only because of the experience they had during their years with TFS but also because they currently work as engineers in the R&D department for Toyota in Belgium. At the time of the interview, they were unaware of the results of our study. The interview questions focused on their skill development on the Formula Student team and their relationship with a real car brand. Following are several excerpts from the interviews:

> "The Formula Student project enables members to develop a wide range of skills, such as teamwork, leadership, time and project management. It is an excellent platform to foster skills, for example commitment to the team, requiring a lot from yourself, being hard-working, and passion. Formula Student represents the state-of-the-art of the automotive technology and a mirror of the latest innovations of the automotive industry" (Andoni Medina, Engineer at Toyota).

It is remarkable that the skills Andoni cites skills are some of the best rated in the assessment carried out by our students. Furthermore, Andoni clearly sees a relationship between the FS competition and the real world at Toyota.

"Enrolling in TFS means striving to reach the goals. Within the team some may find themselves naturally leading people to reach the objectives, some others may develop their project management skills to tackle the various situations requiring complex problem solving. Finally, some others may bring the brilliant idea which can get us around the most frustrating impasse. There is room for all types of profiles but that there is also a common line with all the individuals, which is made out of a strong team spirit, fuelling the strength and striving for success" (Xabier Carrera, Engineer at Toyota).

We have observed that Formula Student is not a platform where everybody develops all the skills, but it is a platform where everybody develops some skills. Here Xabier highlight the fact that in Formula Student there is room for any student, the only

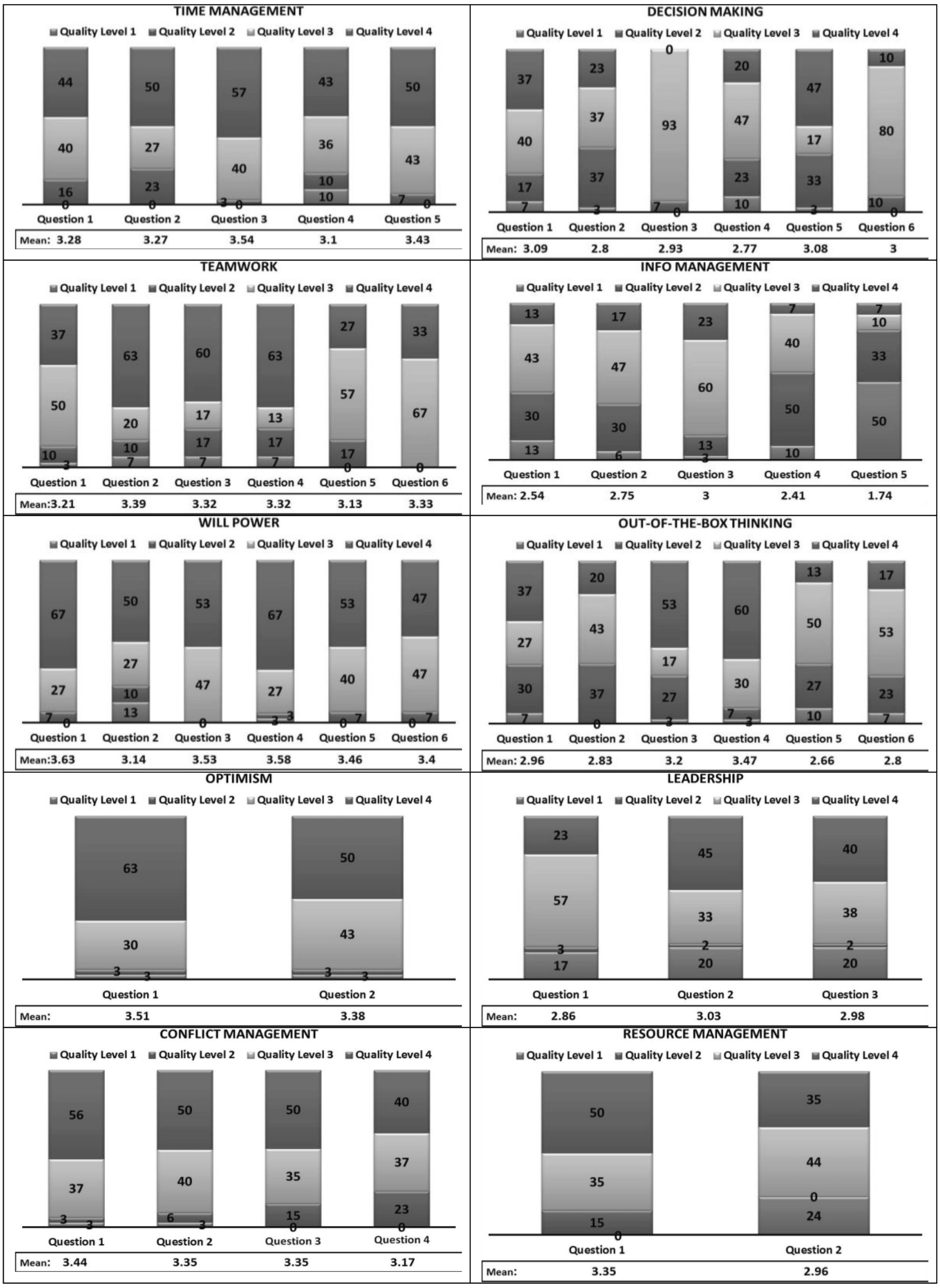

Fig. 3. Summary of the percentage of votes obtained for each quality level in every question of the top-ten skills using the scoring rubric.

condition being to have passion for this field and a strong team spirit.

> "Formula Student is the best platform for educating students about the professional working environment. This appealing competition strongly develops skills like leadership, ambition, project and time management, teamwork and decision making. After working for some time in the automotive industry, I have realised that the FS project is the closest assignment to a job position that a student can have during the university period. Properly developing and putting into practice the skills I mentioned is as key for success in Formula Student as it is for success in professional life" (Alex Ocáriz, Engineer at Toyota).

There is no room for doubt for Alex. Formula Student is an experience that develops many skills, and in his opinion, this college experience is the closest to the actual automotive world.

7. Conclusions

The potential of Formula Student for the development of soft skills has been evaluated. To do this, assessment from the student point of view has been presented. It has been found that this project fosters a group of skills that cannot be developed in regular lectures. It has the unique quality of fostering the aptitudes that engineers from industry want in engineering students. This potential has also been proven by the testimony of three different engineers that participated in the competition and that are currently working in a top automotive company.

The two surveys carried out with the students have also shown that participating in the competition challenges the students and their skills in lots of different ways. However, competing is not enough to fully exercise and develop the skills; proper organization and being aware of the skills that come into play are also necessary for proper skills development, as in the case shown with 'Information Management'.

The positive response obtained from this research encourages the effort that is required by participating in Formula Student, and it also requires deeper study in order to establish more approaches or more routines that lead to greater exercise of the different soft skills.

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