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Take the way of excellence! What makes French engineering schools so attractive for talented students?

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ABSTRACT

Recruiting talented engineering students is a major challenge in most European countries. In France the 'Grandes Ecoles' of engineering have no difficulties attracting the best and brightest students. In this contribution, we would like to investigate why French engineering schools are so attractive. There already exists a great deal of research focusing on the difficulty of entering into these nationally-recognized and highly-prestigious French engineering schools. However, as far as we know, no previous research has investigated why and how these schools have attained this level of attractiveness. The findings that will be presented come from a qualitative research approach carried out in 18 semi-directive interviews with engineering students of diverse origins identified with the help of the BEST student network. In the framework of our exploratory study, we conducted a content analysis for the data in order to isolate and classify emergent themes. Our findings indicate the influence of diverse factors that make French engineering schools attractive for students including their prestige of excellence, professional specialisation in engineering, extracurricular and networking activities, exceptional employability perspectives with access to high ranked positions and the high social status and recognition of engineering profession. The aim of this work is to give a better understanding of why talented students choose to engage in engineering studies within the French context. The overall aim is to try to isolate lessons and good practices that may be applicable to increasing the attractiveness of engineering education in other contexts.

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1 INTRODUCTION

With the development of Industry 4.0, there is undeniably a growing demand for graduate engineers in our globalised and digitalised societies. Despite this growing need for engineering workforce, there is a lack of interest in engineering among young people explained by various reasons like current social ideas about engineering, the image and social status of engineering profession or the financial rewards compared to other career opportunities [1]. It is not surprising that most universities in Europe are currently experiencing difficulties to attract talented young people and engage them in engineering studies.

On the contrary, in France, engineering schools have no difficulties to attract prominent young talents of the country. According to the recent survey of CDEFI (Conférence des Directeurs des Ecoles Françaises d'Ingénieurs) in January 2019, there are 201 engineering schools in France (54 private and 147 public engineering schools) [2]. These engineering schools have a rapidly growing student body with 4% of annual growth during the last decade. From 1990 until today, the number of students graduated in engineering schools has nearly doubled in France. To satisfy the growing demand of the labour market for graduate engineers, the French Ministry of Higher Education, Research and Innovation introduced a long-term strategy to increase the enrolment rate of engineering students by 22.4% until 2026.

In this article, we investigate what reasons French engineering schools are so attractive for gifted students. Our objective is to identify what are the influencing factors of engineering students to enrol in their engineering school. First, we will discuss the very specific engineering education system in France. Then, we will explain the applied methodologies for our research survey. In the next section, we will highlight significant results and their interpretations by outlining unexpected findings. To conclude, we are going to point out the possible implications and the limitations of our study as well as define future perspectives.

2 'GRANDES ECOLES D'INGENIEURS' IN FRANCE

To better understand the culture of 'Grandes Ecoles d'Ingénieurs' in France, we propose to give a historical overview on the origin of this very particular way to educate engineers in the framework of the elite educational system. The creation of the famous 'Ecole Polytechnique' in 1795, considered as the foundation of French engineering education, was the beginning of these very specific engineering schools called 'grandes écoles'. These elite educational institutions provided highly skilled engineering workforce of public servants to conduce to the progress of the French society [3].

The historical development of these engineering schools is closely linked to the political, economic and social upheavals of the 19th and 20th centuries. Thus, the 'Polytechnicians' had an important mission during the Battle of Paris in 1814, during

the Three Glorious and during the establishment of the second republic in 1848 where they played a mediating role between the various parties and participated in the protection of the Provisional Government. After 1870 these engineers strongly influenced the development of transport and modernized the country in depth by creating major traffic networks, new industries, modernization of cities, conquest and organization of a vast colonial empire. In parallel, after 1829 to satisfy the needs of private industrial companies for well-trained engineering managers a special private school network had been developed such as the School of Arts and Crafts for training industrial engineers [4].

Traditionally, the recruitment of French engineering schools is only at postgraduate level. After the A-level exam, young people interested in engineering studies have a choice to enrol in a university without any selection, in a University Institutes of Technology (IUT) with a selection based on satisfying and good results or in a Preparatory Classes to the Grandes Ecoles (CPGE) requiring students with excellent results in secondary school. Even if it's possible to enter engineering schools for a minority of students from universities, IUTs or other ways (e.g.: higher engineering apprenticeship program) the large majority of future engineering students chose to enrol in preparatory classes.

These preparatory classes, viewed as an intensive preparation for the entrance exam in engineering schools, are taking part in the French elite education [5]. They have a reputation as a very high level scientific training, requiring a very intensive daily work during two years and reserved only for outstanding students on the national level. It is interesting that preparatory classes considered as part of higher education but situated mostly in the buildings of secondary school even today. However, breaking this tradition, there are several engineering schools proposing integrated preparatory classes to their future students to facilitate their recruitment process.

The entrance exams, called commonly 'concours', are aiming to recruit the best students: they are highly selective and widely considered as a meritocratic competition requiring not only strong scientific knowledge but also general skills. At the national level, there are five centralised and ranked entrance exams. The exam called 'X-ENS' which is the entrance exam to the Ecole Polytechnique and the different ENS (Superior National Schools) exams are generally considered as the most difficult one, followed by exams called 'Mines – Ponts' and 'Central' grouping together several prestigious engineering schools. The 'CCP' and 'E3A' exams bring together many good engineering schools of various levels. Interesting controversial phenomenon of this selection process that we can find engineering schools with a very various ranking position in the same exam group. For example, the best-ranked engineering school of 'CCP' is considered having a higher prestige than some 'Mines-Ponts' schools or the 'E3A' competition enables to enter the School of Arts and Crafts which is considered quite prestigious.

The first step of the selection process is based on students' results during their CPGE years allowing them to make their inscription generally in several entrance exams.

After this, they have to pass written exams for each 'concours' and in case of satisfactory results an oral exam. At the end of the exams, students are ranked based on their results. Their admission to an engineering school depends not only on their ranking but also the ranking of other students who want enter the same school. As a general rule, students are supposed to choose the better-ranked engineering school available with their results. The ranking of engineering schools changes every year in function of their new students' ranking: the higher the number of students from the top of the competition table, the higher the level of the school. Consequently, the entrance threshold becomes higher attracting even better students in the following years. On the other hand, the oldest schools are generally highly ranked due to their reputation and history as well as the prestigious careers of their former students.

3 ATTRACTIVENESS OF GRANDES ECOLES

During the last two centuries 'grandes écoles' became progressively the symbol of excellence for the French society. What were the reasons for this common belief in their excellence? For Béraud [6], the reputation of these institutions as being the "way of excellence" is based on several reasons. First of all, they provide a high-level professional training with strong knowledge in sciences and human sciences at the same time. Then, the competition based selection with a very high level of entrance exam for recruiting the brightest student on the national level. An engineering diploma of 'grandes écoles' is associated with a high social status and prestige, considered a noble way to obtain high and influential positions like a "ticket for power".

We have to note that these engineering schools have a strong institutional image and identity based on their history and prestige. In his study, including not only engineering schools but also management and business schools, Draelants [7] confirmed the influence of French 'grandes écoles' institutional image on their attractiveness. On the one hand, their attractiveness could be based on this image of excellence explained mainly by instrumental attributes in line with the explanation of Béraud [6]. On the other hand, it could also be based on an image of prestige explained by symbolic attributes like the history of the institution or the identification of students, with their institution. Traditionally, 'grandes écoles' students' are from the middle or upper class of the French society [8]. For these students this image of excellence and prestige increase the attractiveness of these schools. However, it was highlighted that the image of prestige with an extremely competitive selection process could be an obstacle for talented students from lower social classes [9].

Daverne and Massy [10] underlined the role of preparatory classes to influence students' preferences, future ambitions and their choice for engineering school. Many gifted students, with excellent secondary school and baccalaureate results, make the decision to enrol to a preparatory class instead of making a premature choice toward a not sufficiently well-defined professional project. For these students, to go to a university is viewed too risky for their future while the CPGEs providing a recognised high-quality training and the possibility to have an equivalence represent a sure value.

In France, 'grandes écoles' are traditionally considered as an important element of the social reproduction where the social environment, in particular the family has an important role to provide information and to direct their child towards the engineering profession [9]. Beyond the social environment, it is evident that the alumni network of engineering school has a strong influence on their attractiveness. These networks not only reinforce the image of institutions but give the possibility for students to build their social capital during their studies. In several situation (e.g.: internship, first job, professional project, etc.) members of their school's alumni network could provide interesting professional opportunities [11].

4 APPLIED METHODOLOGY

To our knowledge, no prior studies have examined the attractiveness of French engineering schools. For this reason, we decided to apply a qualitative research methodology with a constructivist epistemological approach. Our exploratory study aims at investigating our problematic and provide a better understanding of it for eventual future researches [12].

Our research design based on qualitative data collection by carrying out 18 in-depth interviews with engineering students in three French engineering schools (6 interviews in each school) situated in Paris, Grenoble and Brest. The selection of the participant engineering students was based on the non-probabilistic chain or snowball sampling method relying on initial subjects to generate additional subjects that are relevant to our research topic. We applied this sampling method not only for its cost and time effectiveness but also for the simple reason that it is not easy to reach and involve this specific student population [13]. We contacted and involved our interview participants with the help of local groups of BEST (Board of European Students of Technologies) network.

Our interview guide composed on questions focusing on engineering students' decision-making for choosing their engineering school including their social and personal context. To test our interview guide design, three pilot tests were carried out by three different researchers to reveal the eventual weaknesses and correct them [12]. Before starting the interviews, all participants were informed about the purpose of the study and their right of withdrawal at any time when they desire. Following the principles of ethical research, they received written information about our engagement of confidentiality. They were required to give their written consent to participate in our study. The interviews lasted between 30 and 90 minutes depending on participants' involvement. They were digitally recorded and partially transcribed to make our data analyse process easier.

Our data analyse is based on the qualitative thematic analysis method following the recommendations of Silverman [14] by conducting a comparative keyword analyses (CKA). We followed a three-stage data analysis process. The first stage was a preliminary data analysis stage when three researchers were working independently on the first interpretation of the corpus by carrying out an initial coding. Then, during

the second stage of our data analysis process, these initial codes were converted into standardized codes. In the third stage, we conducted a comparative analysis when researchers used the same codes for corpus analysis. During the data analysis process there was a regular discussion between researchers for reducing the interpretation bias and improve the interpretative validity of our research.

5 RESULTS AND DISCUSSION

Our findings allowed us to identify the following factors of French engineering schools' attractiveness: their prestige of excellence, high quality professional training and extracurricular activities, networking for social capital building and excellent employability and career opportunities.

5.1 Prestige of excellence

It was evoked by several interviewed students that in their high school as they "had great results, especially in physics" (E9) or other STEM subjects, "(our) teachers guide us generally to enter a preparatory class" (E7). In general, their family encouraged them, especially when there are engineers in the family, to follow their career path: "The choice was made for me, because I was good at maths and that I did not know what to do" (E13). Our findings is in line with the work of Dubruc and Boudarel [9] as we perceived a social pressure on students as witnessed by one them: "I was told that it was a bit of the royal way" (E2).

As the principal way to enter an engineering school is to take CPGE, the prestige of excellence of these preparatory classes has a direct positive influence on engineering schools' prestige of excellence. These preparatory classes take on only the brightest students with excellent results as one student in our study said "I think there is really an elite side [...] because being graduated from a preparatory class is not possible for everyone" (E10). Moreover, the prestige of a school is clearly linked to its ranking as it was affirmed by several interviewed students "I tried to have the best I can have, the better ranking" (E3). However, it was surprising that institutional prestige was not mentioned by interviewed students as a consequence the results of Draelants [7] could not be confirmed.

5.2 Professional training and extracurricular activities

Our results show that French engineering schools attract talented young students by providing high quality engineering training with interesting professional specialisations. The interviewed students' choice of their engineering school was often based on the proposed engineering specialisation. As one of them put it into word: "It was a very difficult choice as I hesitated between the prestige and my personal ambitions...I could had been enrolled in [name of a prestigious French engineering school] but my choice was to go in this school because of my passion in [name of a specialisation in engineering]" (E1) and another one added: "I really made my choice based on the specialisation" (E16). In comparison to universities, engineering schools apply a more student-centered pedagogy: teachers are more in the role of a "professional coach"

than a “knowledge transmitter”. Many of the interviewed students affirmed that they feel “well supervised by their teachers”. As one of them affirmed, “The number of students per teacher is less important in engineering schools so we feel to have a good supportive supervision” (E2).

French engineering schools provide traditionally a wide-ranging choice of extracurricular activities to their students. These extracurricular activities, including many students’ clubs, associations with various activities contribute to attract young students to enrol in an engineering school. “Since we are in CPGE, we hear about clubs and associations in engineering schools and it attracts us to enter engineering schools” (E13). An unexpected finding of our study is that these extracurricular activities are viewed by students as an excellent opportunity to develop not only their technical skills but also their transversal skills worthwhile for their future career. All interviewed students participated in several extracurricular activities (in average in three activities).

5.3 Networking and social capital building

As it was confirmed by our findings, networking and social capital building opportunities are an important factor in engineering schools attractiveness. The possibility to create their professional network was considered as one of the major benefits for students to attain their engineering school. As several interviewed students emphasised, it is important to enlarge their friends’ network: “to go in contact with others for the success of my project” (E1) and “to develop relationships with people” (E11) which can be an asset for their future carrier.

Furthermore, according to our findings we have to highlight the role of engineering schools’ alumni to attract gifted young students. Thus, all the interviewed students claimed that they had been influenced in their choice by engineering schools’ alumni: “speaking with alumni is still very important” (E2) and schools, who are aware of that, count on alumni to present their institutions to students in CPGE in the framework of students’ forums. Several interviewed students have been influenced by such events: “Each year, in my preparatory class, there was a forum where all the alumni came to present their school and I discovered my current school at this moment” (E10).

5.4 Employability and career opportunities

Our findings demonstrated the key role of excellent employability and career perspectives in their choice of enrolling in a ‘grande école’. For all participating engineering students, graduating from an engineering school represents a “job security” for their life and a kind of guarantee “being in a financially comfortable situation with a correct salary” (E7). Another student added that “there is no concern about employability” (E5). However no one from the interviewed students has even a rough idea what could be exactly a correct salary. It could be explained by the fact that we interviewed Z generation students (were born after 1995) whose importance is “having happiness and enjoyment in their career” and not particularly worried about money [15:4].

This job security means not only having a satisfactory job but also having excellent long-term career perspectives. Being graduated in an engineering school was considered as a kind of guarantee to be in a good position on the labour market as it was affirmed by Béreau [6]. "When you come out of engineering school, you have more credibility than when you come out of a [name of a university diploma] (E7). It is interesting that the flexibility and manifoldness of engineering career was perceived by interviewed students as an important motivational factor for enrolling in an engineering school. A participating student indeed explained: "The flexibility [engineering studies] enable in one's choices of life comforts me" (E6).

6 CONCLUSION

Attractiveness of engineering is an important matter all over in Europe and considered as one of the five priority themes of SEFI. Consequently, attractiveness of engineering schools with a direct and significant influence on engineering education is a hot topic. Our exploratory study intends to give a better understanding of engineering schools attractiveness thorough our investigation of French engineering schools good performance to attract talented young students that could be extended in an international context.

Being an engineering student in a prestigious French engineering school is related to a very positive image and high social status. It seems to be obvious that the attractiveness of French engineering schools could come from their prestige. However, in our study we identified other important influencing factors on engineering schools' attractiveness. Between these factors, we would like to highlight the importance of job security and employability perspectives evoked by all students participating in our study. As a consequence, engineering schools in their recruitment process should put more emphasis on good engineering employability perspectives for improving their attractiveness. According to our findings, the direct involvement of their alumni in it could provide an efficient promotion for recruiting future students.

The principal limitation of our study is that we interviewed only engineering students who passed a successful entry exam to enrol in their engineering school. Future studies could fruitfully explore this issue further by questioning students who are in preparatory classes. It would be interesting to investigate the perception of teachers and academic staff in engineering schools and preparatory classes. Regardless, future research could continue to explore this question at the European level in the framework of a comparative study.

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