Industry Validation of a Professional Roles Model to Promote Engineering Identity of Young Graduates

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ABSTRACT

In order to offer engineering students a framework to get a grasp on the diverse engineering field, a Professional Roles Model for Future Engineers has been developed by Craps et al. (2018). In this model, three distinct engineering roles are defined: Operational Excellence (focus on optimization); Product Leadership (focus on innovation); Customer Intimacy (focus on tailored client solutions). In this study, we will investigate how industry professionals perceive the model in their company. Additionally, we will determine which professional competences discriminate between the three roles. A survey was distributed at several job fairs for engineering students in Flanders, Belgium. In total, 188 industry professionals returned the survey. In the first section, respondents rated to which degree they (1) recognized the three professional roles in their company and (2) were able to place job vacancies for young engineering graduates in the model. In a second section, respondents were asked to rate the importance of 15 professional competences (e.g., creativity, empathy...) for each of the three professional roles. Overall, industry professionals responded positively to the model: 66% (strongly) recognized the three professional roles in their company and 59% could easily classify positions for young engineers in this framework. In terms of professional competences, especially the customer intimacy role contrasted strongly with the other two roles: client focus, empathy and building

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relations were rated significantly more important in a client-focused role. Conversely, creativity and innovation were of greater importance in a product leadership role.

1 INTRODUCTION

1.1 Engineering student employability

It is commonly accepted that successful engineers must hold a well-balanced set of technical and professional skills [1]. Engineering institutions have various ways to train their students in both areas. In their systematic literature review, Winberg et al. [2] discerned different positions to conceive employability along two continua: engineering science on the one hand and professional skills on the other. For example, one category of positions focuses on establishing a strong disciplinary foundation and professional skills are embedded in this engineering science foundation. In another position, stand-alone professional skills development course are implemented, independently of the mainstream engineering courses. According to the authors, the latter courses tend to be sometimes misaligned with the disciplinary content.

However, Magnell et al. [3] indicated that the term employability is an ambiguous concept. In a narrow sense, it is often conceptualized as the ability to get a job after graduation or as a set of skills (as outlined above). In line with Knight and Yorke [4], the authors endorse a broader meaning of the term employability by making claims in four areas: understanding, skillful practices, efficacy beliefs and metacognition. This conceptualization is more comprehensive as it combines knowledge and skills with students' self-perceptions of their own skills levels and their ability to apply knowledge and skills in a particular context. Especially the latter element, meta-cognition, is important in that it refers to learners' capability to look at themselves and reflect upon self-perceived skills levels, strengths, and weakness. Prior research by Nilsson [5] and Cech et al. [6] indicates that when students are able to articulate their strengths and weaknesses and gain confidence in a particular engineering role, this increases their employability and persistence in engineering.

In this respect, triggering engineering students to reflect on their professional future is an important challenge for engineering institutions [7]. Prior research showed that explicitly articulating student social identity and career goals has beneficial consequences for student learning [8]. In this respect, Bennett and Male [9] indicated that engineering students need more opportunities to explore both the roles of engineers and their possible future selves.

1.2 Professional role model

In order to offer engineering students a framework to (1) get a grip on the diverse engineering field and (2) offer them a starting point for developing their own engineering identity, a Professional Roles Model for Future Engineers has been developed by Hofland et al. [10]. In this model, three distinct engineering roles are defined, each with a very specific focus: Operational Excellence (process optimization & increasing efficiency); Product Leadership (radical innovation & research and development); Customer Intimacy (tailored solutions for individual clients). In their study, Craps et al. [11] were able to define the three professional roles using 23 professional competences. Through an extensive Delphi design, the authors organised 13 qualitative expert panels in industry. The output resulted in a competence mapping of 23 professional competences on the Professional Roles Model. For example, innovation, out-of-the-box thinking and creativity were deemed more important in a Product Leadership role whereas client focus, capacity for empathy and clear communication were considered indispensable in a Customer Intimacy role. A comprehensive overview is subject of a paper in progress and available on request.

1.3 Industry influences on the engineering curriculum

In developing tools that could be helpful in increasing engineering students employability, external influences (e.g., employers or business professionals) could be of particular interest. Barnett [12] found that there is a degree of variation in the extent to which external influences affect curricula in higher education. Examining perceptions of a large sample of faculty staff (N=363), Magnell et al. [3] found that most faculty members were generally interested in including work-related issues (e.g., guest lectures, project work) in their teaching. Interestingly, two observations regarding their extensive sample are noteworthy. First, about 50% of the respondents did not have prior experience in industry. Second, a quarter of the respondents indicated that they did not have contacts outside of academia in the past year. This observation is surprising, given that there is an increasing call from industry stakeholders to increase work-related learning in engineering education. It is generally assumed that better linkages to working life have beneficial consequences for the employability of students.

Therefore, in developing a framework for professional roles intended to enhance engineering students' employability, the input and support of industry is indispensable. Hence, the prime objective of this paper is to report on the industry perceptions of the Professional Roles Model developed by Hofland et al. [10] and Craps et al. [11]. In their study, Hofland et al. [10] gauged the perceptions of industry through 5 qualitative in-depth interviews with HR managers. Almost all interviewees recognised the model in the recruitment process of graduated engineers.

In this study, we aim to extend the findings of Hofland and colleagues by examining the external validity of the professional roles model in a diverse sample of business professionals, both with and without an engineering background.

1.4 Research questions

Follow research questions (RQ) will be addressed in this paper:

RQ 1 *"To what degree do business professional recognize the professional roles model as a way to classify positions for young engineers?"*

› Are there statistical differences in the perceptions (a) between respondents with an engineering, HR or marketing background and (b) between employees of small, medium-sized or large companies?

RQ 2 *"To what degree can business professionals apply the model to positions for engineering graduates in their company?"*

› Are there statistical differences in the perceptions (a) between respondents with an engineering, HR or marketing background and (b) between employees of small, medium-sized or large companies?

RQ 3 *"How are positions for young engineering graduates typically filled in (one specific role, combination of two or three roles)?"*

- Are there statistical differences in role implementation between employees of small, medium-sized or large companies?

RQ4 "*What is the relative importance of 15 professional competences for each of the three professional roles?"*

2 METHOD

2.1 Sample

An extensive survey was distributed on paper and pencil during the job fairs in the spring of 2018 at 6 different university campuses. Together with the survey, each company representative received a small leaflet with a brief explanation of the Professional Roles Model. At the end of each of the job fairs, all surveys were collected from the booths. In total, 188 completed surveys were retrieved.

In the first part of the survey, background information was collected from all respondents. Regarding the company size, following proportions were observed: large company (>250 employees - 57%), medium-sized companies (50-250 employees – 28%), small companies (10-50 employees – 12%) and micro companies/start-ups (<10 employees – 2%). In terms of professional background, 51% of the respondents held an engineering degree whereas 47% came from the HR department. Overall, the companies are active in a wide variety of sectors (construction, IT, petrochemical industry, manufacturing, automotive…). Due to the large degree of heterogeneity, the sector was not included as a covariate in our statistical analyses.

2.2 Survey

Perceptions Professional Roles Model

In the first part of the survey, we measured company representatives' perceptions of the Professional Roles Model through three descriptive questions. First, representatives were asked to which degree they recognized the model as a framework for classifying the wide range of engineering functions. This item was rated on a 5-point Likert type scale ranging from 1 ('*Not at all recognizable to me'*) to 5 ('*Completely recognizable to me'*). Second, respondents were asked to which degree they were able to position young engineers in their company in this framework. This item was also rated on a 5-point Likert type scale ranging from 1 ('*Very easily*') to 5 ('*Very hard'*). Finally, we gauged the respondents perceptions on how engineering positions were filled in their respective company (i.e., in a single role, in a combination of two roles, or a combination of all three roles).

Associated competences

In the second part of the survey, company representatives were requested to evaluate the importance of 15 professional competences for each of the three professional roles (for a full overview and definition of the 15 competences, see Appendix 1). These 15 competences were chosen on the basis of two expert panels with engineers in the field (the expert panels were the first two panels of the more extensive research reported by Craps et al. [11]). A panel consisted of 6 to 8 engineers supplemented with colleagues from HR. Through a systematic approach, participants were instructed to select the essential competences for each of the three roles. The resulting 15 competences were included in the current survey. For each professional roles, respondents were asked to rate the importance of each competence on a 5-point Likert type scale ranging from 1 (‘*Not important at all*’) to 5 (‘*Very important*’). For the complete competence mapping, we refer to Craps et al. [11].

3 METHOD

3.1 Analysis of Variances (ANOVA)

In order to evaluate statistical differences regarding perceptions of the professional roles model between different company sizes, ANOVA analysis were performed. Analogously, statistical differences regarding the importance of particular competences between the three professional roles were evaluated using this technique.

4 RESULTS

4.1 Industry perceptions of the Professional Role Model

At a descriptive level, there seems to be general agreement on the Professional Roles Model: 65% of the respondents (easily) recognizes the model for classifying engineering graduates in their respective company (Fig. 1).

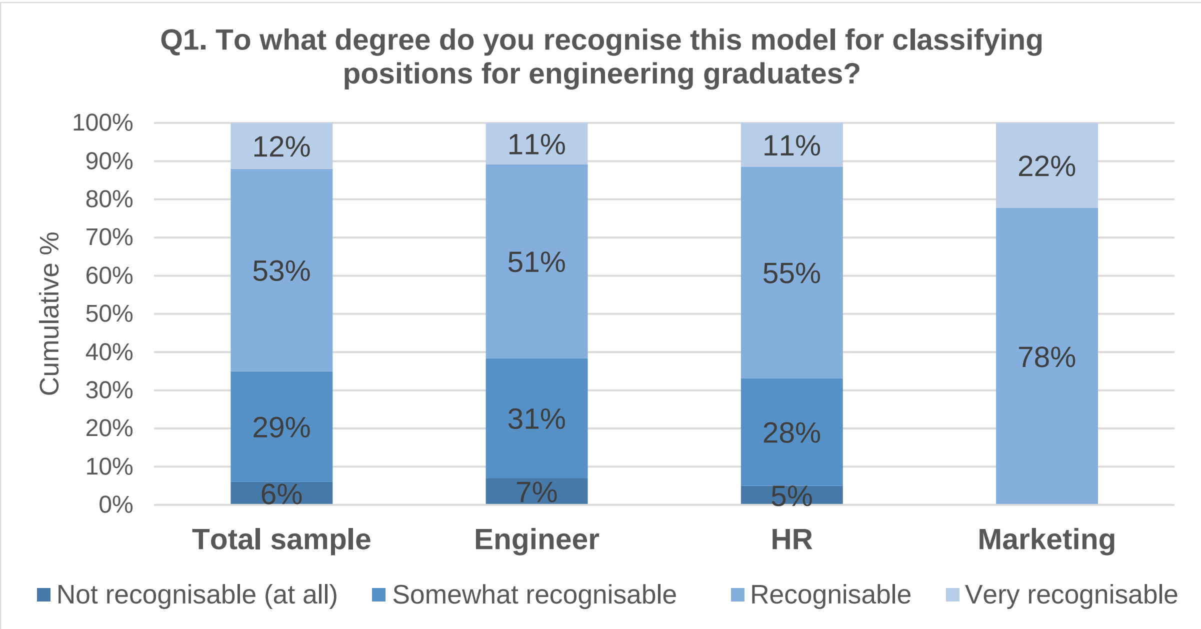

Fig. 1 Industry perceptions of the professional roles model (total sample, engineering, HR & marketing background)

Interestingly, there are only minor differences in the perceptions of engineers, HR professionals, and marketing professionals. A more detailed analysis of the respondents who replied negatively to this item indicates that these were predominantly active in the ICT business. There was no significant effect of company size on degree of recognisability of the model, F (3,179) = 1.43, p=.24. Hence, the model seems to be supported equally well in small, medium-sized and large companies.

In a follow-up question, respondents were asked to which degree they could place the company's job positions for young engineering graduates in this model. 60% of the respondents indicated that they were (very) easy able to link positions for young engineering graduates to this model (Fig. 2). Little to no differences are observed in the response pattern in function of the role inside the company. Additionally, there was no significant effect of company size on company-specific implementation of the model, F (3,180) = 1.24, p=.30. Hence, irrespective of the company size, most respondents indicated that it was rather easy to classify positions for young engineers into the model.

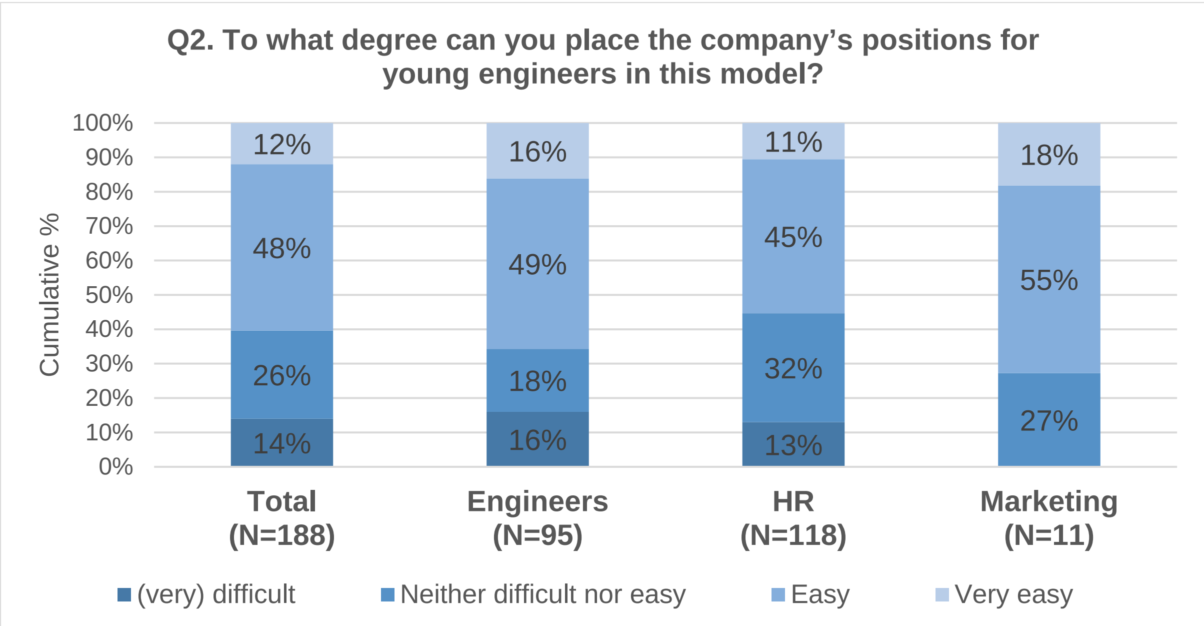

Fig. 2. Industry perceptions on the applicability of the model in their company (total sample, engineering, HR & marketing background)

When participants were asked how the different roles were applied inside their company, around 55% of the respondents indicated that most engineering positions required a combination of two roles (Fig. 3). Also for this question, no statistical differences were observed for different company sizes.

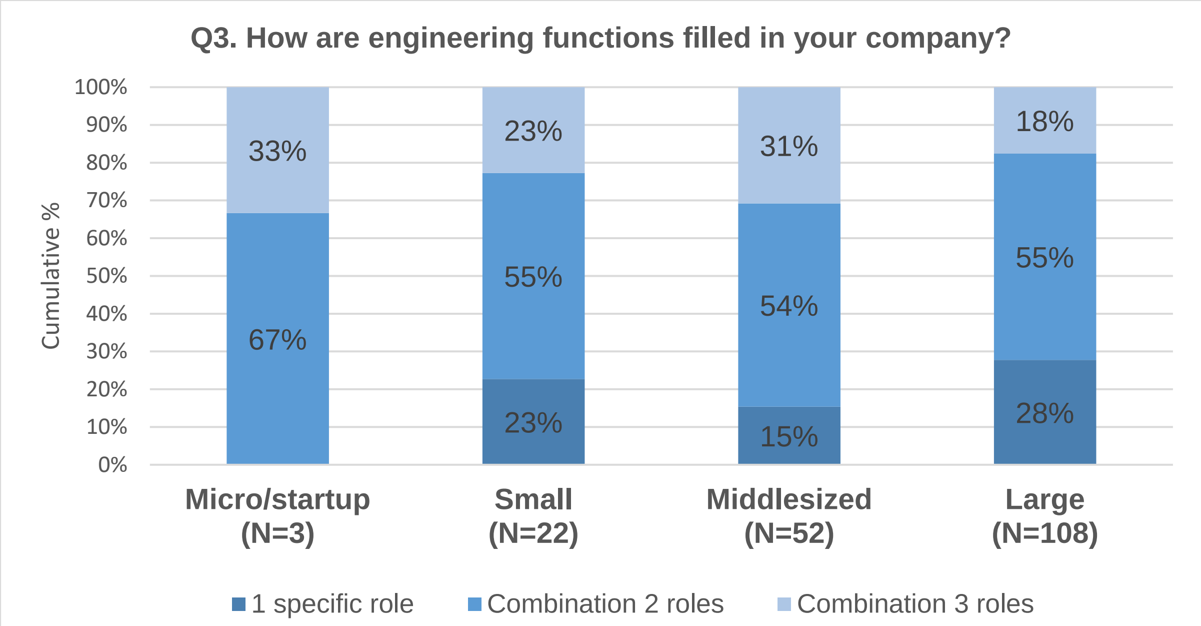

Fig 3. Composition of engineering positions in industry, based on the three professional roles (per company size)

4.2 Associated competences

In the second section of the survey, the respondents were requested to rate the relative importance of 15 professional competences for each of the three professional roles on a 1-5 Likert type scale (for a descriptive overview, see Fig. 4). A general observation is that the average importance of all professional competences is rather high. For example, the average importance of solution orientation and goal orientation is high in all three professional roles with average scores ranging between 4.15 and 4.48 and 4.19 and 4.49 respectively. This finding indicates that these qualities are expected from engineering graduates, irrespective of the professional role.

As shown in Table 1, for all professional competences we found statistical differences between the three professional roles. The largest differences are observed for client orientation ($F(2,477)=108.38$, $p<.001$), building relations ($F(2,471)=79.12$, $p<.001$), and capacity for empathy ($F(2,472)=68.64$, $p<.001$). All three competences were deemed considerably more important for engineers working in a Customer Intimacy role. For the Product Leadership role, creativity, innovation skills, and conceptual thinking were rated significantly more important compared to the other two roles (Fig. 4). Finally, planning and organizing, insight in the organisation, realism and result orientation were somewhat more pronounced in an Operational Excellence role.

In conclusion, these findings indicate that industry professionals attach different relative values to the three professional roles in terms of professional competences. These results illustrate that is possible to define and discriminate the three professional roles identified by Hofland et al. [10] based on a number of clearly defined competences and Likert type scales.

Table. 1. Results ANOVA test statistical differences of importance competences for the three professional roles.

Competence	df	F-value	Sig
Planning and organization	2,480	18.45	<.001
Insight in the organization	2,470	9.32	<.001
Positive critical attitude	2,474	9.81	<.001
Decision-making	2,469	8.65	<.001
Client orientation	2,477	108.38	<.001
Creativity	2,478	32.85	<.001
Innovation	2,471	59.24	<.001
Capacity for empathy	2,472	68.64	<.001
Building relations	2,471	79.12	<.001
Realism	2,468	9.68	<.001
Conceptual thinking	2,473	37.14	<.001
Result orientation	2,472	11.516	<.001
Persuasion	2,472	26.99	<.001
Solution orientation	2,470	7.14	.001
Goal orientation	2,473	5.81	.003

5 DISCUSSION

The prime objective of the Professional Role Model developed by Hofland et al. [10] is to offer engineering students a grip on the complex engineering reality. Thorough industry validation of the model is indispensable in this respect. In sum, we can conclude that the Professional Roles Model is generally supported by a variety of industry stakeholders. About 2/3rd of the respondents recognized the model to classify functions for young engineering graduates and about 60% agreed they could apply the model in their respective company. Altogether, we did not observe statistical differences between (1) the respondents' professional background (engineering, HR or marketing) or (2) the company size. These findings illustrate that the model seems to be widely applicable across different industrial sectors. However, it should be noted that current description of the model might not be sufficiently tailored to the ICT sector, resulting in an impaired interpretability by IT professionals. The majority (55%) of the industry professionals indicated that most engineering positions in their company required a combination of two roles. No statistical differences were observed in this respect between small, medium-sized and large companies.

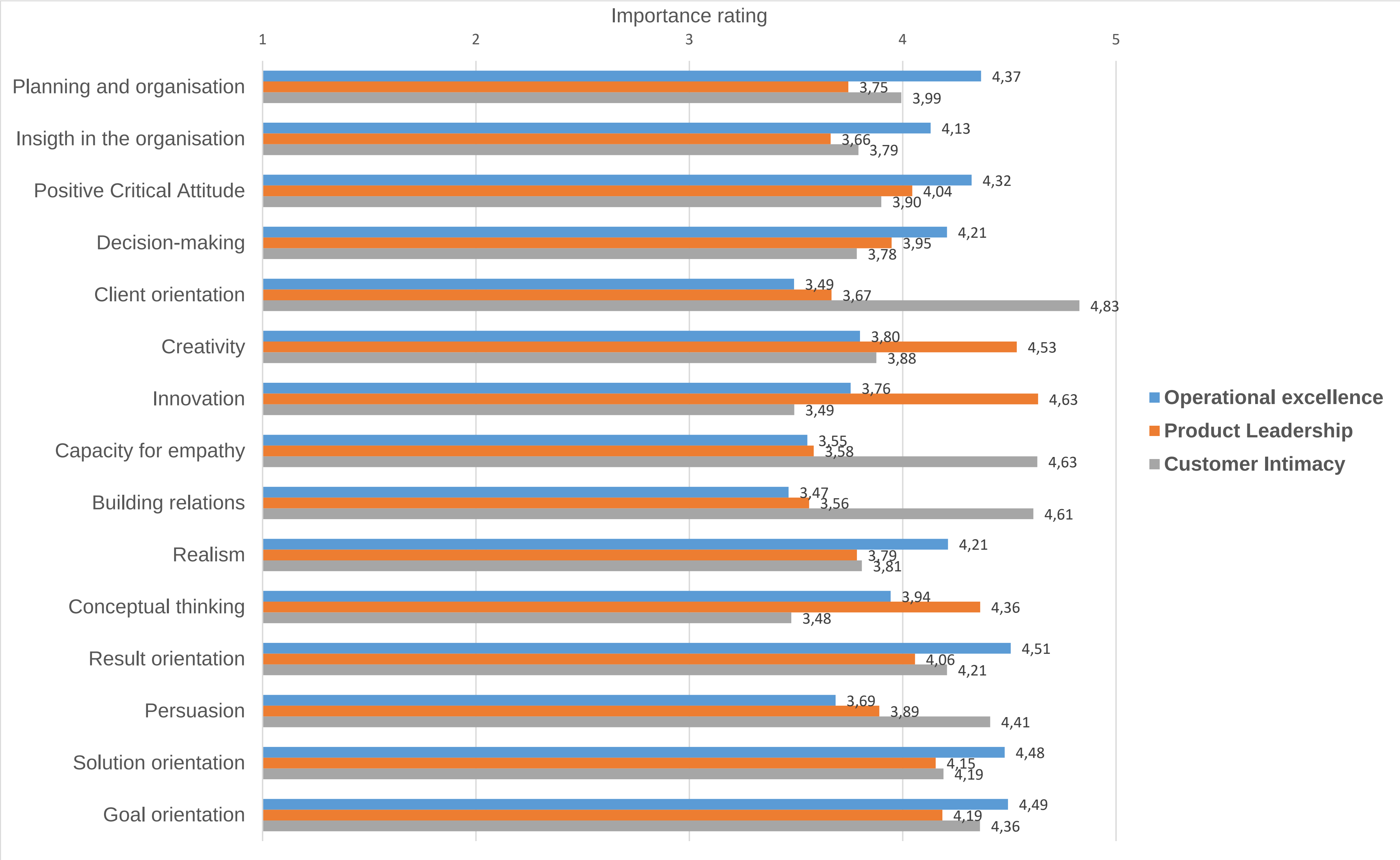

Fig. 4. Perceived importance of 15 professional competences for each of the professional roles.

Furthermore, our findings indicate that business/industry professionals hold different expectations towards the three professional roles in terms of the required professional competences. For example, capacity for empathy and client focus are deemed more important for a customer intimacy role whereas creativity and conceptual thinking are more pronounced in a product leadership role. These findings indicate that industry has different expectations towards engineers working in a different role (also see [13]).

Although the present study yielded a number of interesting findings, a number of limitation should be addressed. First, to measure the (relative) importance of a number of professional competences for each role, we relied heavily on quantitative methods. Recent research by Craps et al. [11] showed that mixed method research (a combination of quantitative and qualitative methods) has promising potential for identifying competences profiles. Using Likert-type scales, the respondents might be driven by a propensity to provide the maximum score for each of the competences. This propensity could stem from a desire for versatile engineers who excel in a wide variety of skills domains. By analogy of the hungry caterpillar, industry professionals might lose themselves in a quest for their white knight. Qualitative focus group discussion might be an interesting avenue to refine our understanding which competences are quintessential for each of the three professional roles. Second, we explored industry perceptions on the professional roles model but unfortunately this method does not enable a deeper understanding of difficulties in the interpretability of the model. A superficial analysis hints at a slightly impaired interpretability in the IT field but due to the closed survey format, this could not be explored in greater detail. In this sense, this study provides valuable insights on how the model specification could be improved to be applicable to a wider student population.

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APPENDIX

Appendix 1. Competences and definitions

No.	Competence	Definition
1	Planning and organizing	*… determines goals and priorities effectively. (S)he clearly indicates the time, activities and resources needed to achieve goals.*
2	Client orientation	*… attunes his/her own actions to the feelings, needs and wishes of internal and external clients, even when these are not directly expressed.*
3	Creativity	*... approaches problems from different angles, contributes new and original ideas and solutions, and breaks through established thinking patterns.*
4	Insight in the organization	*… thinks cross-functionally and acquires insight into and determines the policy parameters.*
5	Innovation	*... has and encourages new, original ideas, working methods, processes and applications. He/she focusses on future innovation in strategy, products, services and markets with an inquiring and inquisitive mind.*
6	Capacity for empathy	*... listens to and thinks along with others. (S)he acknowledges the feelings and needs of others, puts him/herself in others' shoes and consciously deals with different backgrounds and interests.*
7	Positive critical attitude	*... reflects on the methods, techniques, processes and strategies used by the company. (S)he questions them in a positive manner.*
8	Building relations	*... builds relationships and networks with people within and outside of the organisation, at different levels and from different cultures that are important for the goals of the organisation or organisational unit.*
9	Realism	*... demonstrates a good sense of the feasibility of his/her ideas and instinctively and intuitively chooses the right course of action.*
10	Decision-making	*... can take appropriate decisions within the scope of his/her given responsibilities, accounting for risks, limited information, existing issues and situational requirements.*
11	Conceptual thinking	*… can think conceptually and turn concepts into workable solutions.*
12	Result orientation	*... is focused on translating - concretising - goals and achieving results in accordance with timeframes, standards and agreements.*
13	Persuasion	*... obtains buy-in for ideas and proposals by making the right arguments - at the right time and in an appropriate manner and so (s)he has an influence on others.*
14	Solution orientation	*… thinks in terms of solutions. (S)he does neither ignore problems nor unnecessarily consider a given situation a problem.*
15	Goal oriented	*... has the commitment, will and ambition to generate results for the organisation and to achieve organisational objectives or targets.*