

ENGINEERING INNOVATION AND MARKET SUCCESS: EXPLORING THE NEED FOR ENGINEERS' MARKETING SKILLS

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Abstract. Resulting marketing and engineering product goals require engineering and marketing to be interconnected, as the unity of engineering innovation and its marketing leads to product market success. Sustainability affects product market success. The aim of this study is to explore the need for engineers' marketing skills, both theoretically and empirically. The present work represents exploratory research. Theoretical research is based on the analysis of scientific literature available via Google search. This empirical study was conducted in the year 2024. A total of 209 undergraduate engineering students studying computer science in India participated in an online survey. Data from the online survey were processed via frequency analysis, percentage, and ranking. Theoretical analysis allows us to conclude that sustainability is the cornerstone in modelling engineers' marketing skills, as well as in the creation of engineering innovation (product design). Theoretical research results in modelling engineers' marketing skills, consisting of five sub-skills. The empirical study found that social media marketing skills for engineers who represent the digital economy are the most important. Engineers' marketing skills are an emerging research area. The limitations of this theoretical analysis and empirical study are highlighted. Future research directions are proposed.

Keywords: engineering, marketing skills, market success, product design, ranking, social media marketing, sustainability.

To cite this article:

Ahrens, A., Bhati, P., Zascerinska, J., Bikova, A., Aleksejeva, L., Zascerinskis, M., Olga Gukovica, O., & Abjalkiene, I. (2024). Engineering Innovation and Market Success: Exploring the Need for Engineers' Marketing Skills. *Education. Innovation. Diversity*, 2(9), 6 – 16. DOI: <https://doi.org/10.17770/eid2024.2.8279>

Introduction

Sustainability is a key factor driving modern engineering product design and market demand. Sustainability aims at creating engineering products that meet the needs of today's consumers (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024). Sustainable solutions in product design and its further marketing relate to material selection, energy efficiency, recyclability, and end-of-life disposal (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024).

Conventionally, engineers design an innovative product, and marketers sell this product to customers for further use (Bumblauskas, Carberry, & Sly, 2017) as shown in Figure 1.



Figure 1 Inter-connection between product design, product marketing, and product selling results (by authors)

Therefore, engineering and marketing exist in isolation from each other (Michalek, Feinberg, & Papalambros, 2005). This isolation does not result in optimal product offers, as engineers work within the limits of their capabilities, while marketers are bounded by customer preferences (Michalek, Feinberg, & Papalambros, 2005) as illustrated in Figure 2.

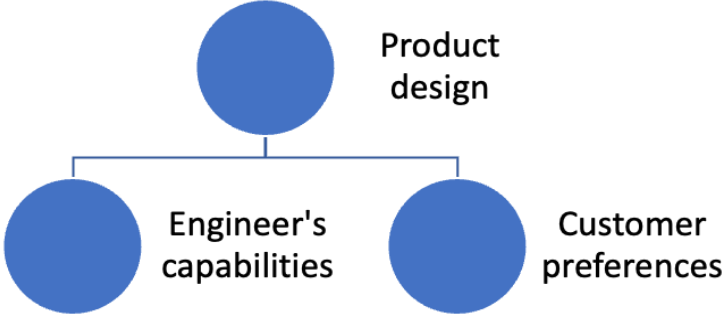


Figure 2 Inter-connection between product design, engineering capabilities, and customer preferences (by authors)

Further, the resulting marketing and engineering product goals require consideration of engineering and marketing as interconnected (Michalek, Feinberg, & Papalambros, 2005). Engineering product design, adapted to users’ needs and preferences (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024), increases product demand and sales. Figure 3 illustrates the unity of product design and marketing, leading to product market success.

The aim of this study is to explore the need for engineers’ marketing skills both theoretically and empirically.

The present work represents exploratory research. It includes both theoretical and empirical explorations of the need for engineers’ marketing skills. Theoretical research is based on the analysis of scientific literature available via Google search. This empirical study was conducted in the year 2024. A total of 209 undergraduate engineering students in the field of computer science participated in an online survey. Data from the online survey were processed using frequency analysis and ranking.

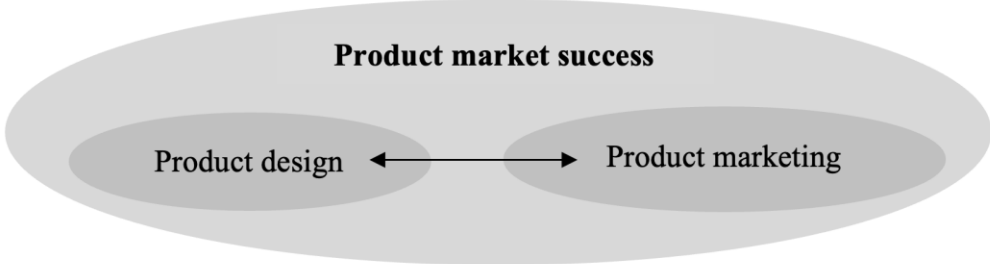


Figure 3 The unity of product design and product marketing leading to product market success (by authors)

Research Methodology

The present study was exploratory in nature. This type of research is chosen when the topic of engineers’ marketing skills is underexplored (Ahrens & Zašcerinska, 2021). Only two scientific publications on engineers’ marketing skills were found via Google searches. Table 1 presents the publications available via Google search for further analysis.

Table 1 Scientific publications on engineers' marketing skills (by authors)

No	Publication title	Reference
1	The role of "Engineering Marketing" study course in raising the prestige of market-minded engineers in the context of digital economy	Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020
2	Product Design	Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024

The lacuna in research on engineers' marketing skills requires exploratory efforts in this work. Exploratory research is empowered by researchers' openness to launch the study (Ahrens, Zascerinska, Bhati, Zascerinskis, & Aleksejeva, 2021). Exploratory research also means that research can be performed with high flexibility for building a structure in the analyzed research field (Ahrens, Foerster, Zašcerinska, & Wasser, 2020). Exploratory research may result in the creation of a new theory, formulation of hypotheses, or proposal of new research questions (Phillips, 2006). The newly introduced theories, hypotheses, or research questions, which were elaborated within exploratory research, can be tested for generality in subsequent research work and/or studies (Mayring, 2007).

The present exploratory research was enabled by the research questions:

1. Is there a need for engineers' marketing skills?
2. What are engineers' marketing skills?
3. What is engineering students' self-evaluation of their marketing skills?

The present work, devoted to the exploration of the need for engineers' marketing skills, is implemented in three steps.

1. Theoretical analysis,
2. Empirical study, and
3. Synthesis of theoretical and empirical findings.

Theoretical research comprises the analysis of scientific literature available via Google search. Google search revealed only five scientific publications on the topic of the present research, namely, the inter-connections between engineering innovations (product) and marketing. Table 2 presents the publications selected for further analyses.

Table 2 Scientific publications on the research topic (by authors)

No	Publication title	Reference
1	Linking Marketing and Engineering Product Design Decisions via Analytical Target Cascading	Michalek, Feinberg, & Papalambros, 2005
2	Selling Technical Sales to Engineering Learners	Bumblauskas, Carberry, & Sly, 2017
3	The role of "Engineering Marketing" study course in raising the prestige of market-minded engineers in the context of digital economy	Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020
4	Marketing capabilities to grant a competitive advantage to engineering	Piedrahita, Zapata, Zapata, & Rosero, 2020
5	Product Design	Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024

Theoretical analysis started with defining "engineer," "marketing," "marketing process," "indicator of marketing process success," and "skills," afterwards, further moving to the elaboration of the definition of "engineer's marketing skills."

The exploratory empirical study was implemented in 2024.

This empirical study was facilitated by the following research question: What marketing skills are important for student engineers?

The purpose of this empirical study is to analyze student engineers' opinions on the importance of marketing skills.

A total of 209 undergraduate engineering students enrolled in computer science study programs in India participated in the online survey. Therefore, the respondents represented a digital economy. It should be noted that, prior to the commencement of the study, verbal informed consent for participation in the study had been obtained from the online survey participants.

Table 3 describes the respondents' computer program and software skills.

Table 3 Summary of the respondents' computer programmes and software skills (the authors)

Computer programmes and software skills	Frequency	Ranking
Programming languages (HTML, CSS, JavaScript, Python, etc.)	184	1
Cloud computing	52	5
Front-End Development	66	3
Back-End Development	64	4
Cybersecurity	77	2

Source: Online survey.
n=209

Table 3 shows that the respondents obtained computer programs and software skills in programming languages, cybersecurity, and front-end development. Table 4 presents the choices of options per respondent relevant to their computer program and software skills.

Table 4 Respondents' options related to their computer programmes and software skills (by authors)

No	Answer option	Frequency	Percentage
1	One option answer	76	36%
2	Between two and four option answer	116	56%
	All the five options selected	17	8%

Source: Online survey.
n=209

The results in Table 4 emphasize that the majority (56%) of the respondents had multiple skills in computer programs and software.

Table 5 characterizes the respondents' digital skills.

Table 5 Summary of the respondents' digital skills (the authors)

Digital skills	Frequency	Ranking
User Experience (UX)	131	1
Wireframing	34	5
Responsive Design	74	3
Branding	69	4
Visual Design (Color Theory, Typography, etc.)	94	2

Source: Online survey.
n=209

Table 5 highlights that the respondents were most experienced in user experience digital skills, visual design, and responsive design. Table 6 shows the choices of options for each respondent relevant to their digital skills.

Table 6 Respondents' options related to their digital skills (by authors)

No	Answer option	Frequency	Percentage
1	One option answer	70	33%
2	Between two and four option answer	130	62%
	All the five options selected	9	4%

Source: Online survey.

n=209

The results in Table 6 reveal that the majority (62%) of respondents had multiple digital skills.

The online survey was based on the question, "What marketing skills are important for you?" This question in the online survey was a multiple-choice option. Respondents could select one to five options.

- Social Media Marketing,
- Content Management Systems,
- Consumer Analytics
- Email campaigns, and
- Creating Marketing Funnels.

Table 7 illustrates the respondents' responses.

Table 7 Respondents' options in the online survey (by authors)

No	Answer option	Frequency	Percentage
1	One option answer	71	34%
2	Between two and four option answer	132	63%
	All the five options selected	6	3%

Source: Online survey.

n=209

Table 2 shows that 71 respondents or 34% answered the online survey question selecting only one option, while 132 respondents or 63% used between two and four options. Six respondents or 3% answered using all the five options. Therefore, the majority of the respondents or 63% preferred multiple answers.

Therefore, an online survey was used for data collection. The collected data were analyzed using descriptive statistics, frequency analysis, percentages, and rankings (Ahrens & Zascierinska, 2020). Frequency analysis helps to compare marketing skills for the establishment of the most and least important ones. Percentage allows comparison and review of results from surveys and/or studies. Ranking shows the vertical differences between options (Marginson & van der Wende, 2007). Therefore, ranking was found helpful in selecting the appropriate marketing sub-skills to be obtained by student engineers (Ahrens & Zascierinska, 2020).

After the data were collected and processed, data analysis and interpretation were performed. All these data processes were organized by the researchers who implemented the empirical study within the present research (Ahrens, Purvinis, Zašcerinska, Micevičienė, & Tautkus, 2018).

Research Results

1. Theoretical Results

Analysis of scientific literature identified that engineering marketing represents a new paradigm in marketing evolution which determines the corresponding requirements for

engineers (Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020). Engineering marketing bridges engineering principles with user-centered design to create innovative and appealing products (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024). The decomposition of the term engineering marketing shows its structural elements, as depicted in Figure 4.

Engineering is a generator of progress (Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020). Engineers are key actors in engineering. Engineer has the ability to integrate his/her engineering capabilities and customer preferences through technical solutions (in other words, engineering innovations or products) providing the prospect for stakeholders to participate in development and adaptation of goods and services (Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020). By stakeholders, designers, engineers, marketers, and others who help ensure that the resulting product aligns with the intended goals and satisfies user requirements (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024). Thereby, product design requires a multidisciplinary approach involving all stakeholders' collaboration (Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024).

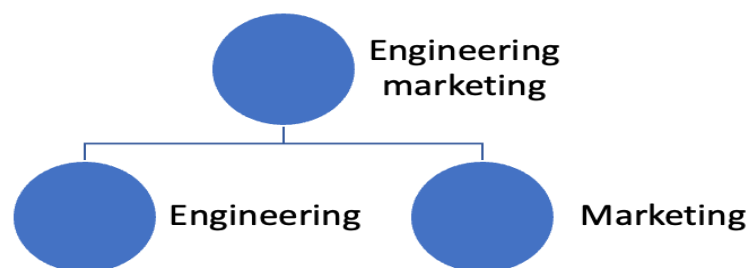


Figure 4 *Structural elements of engineering marketing (by authors)*

Marketing is a customer-focused process aimed at selling and/or promoting products. Marketing is based on plurality, independence and self-sufficiency (Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020). The marketing process includes (Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020)

- marketing communications,
- market research,
- marketing methods, and
- models, etc.

Additionally, the increasing role of social media in marketing has to be emphasized (Ahrens, Zasczerinska, Huliaieva, Duranowski, Dąbrowski, Santos, Oliveira, Rodrigues, & Oliinyk, 2024). Social media links engineers with all the relevant stakeholders, thereby strengthening their cooperation and contribution to regional development as well as economy (Ahrens, Zaščerinska, Amanzholova, Aleksejeva, Zaščerinskis, Aleksejeva, Gukovica, & Abjalkiene, 2021).

As any process, marketing process can be measured and evaluated (Ahrens, Zasczerinska, & Aleksejeva, 2021). One of the indicators used to measure developmental dynamics in the marketing process is engineers' skills (Zaščerinska, 2013). By skill, an engineer's ability to act aims to accomplish a task with the required quality and volume (Ahrens & Zasczerinska, 2023).

Table 8 provides an overview of marketing skills and their structural elements found in the scientific literature available for analysis.

Table 8 *Marketing skills' definitions (by authors)*

Marketing skills	Market sub-skills	Reference
Marketing method	<ul style="list-style-type: none"> - Team work - Cooperation 	Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020
Marketing model	<ul style="list-style-type: none"> - Idea - Implementation - Scope - Competition - Engineering marketing tools - Calculation methods - Engineering marketing evolutionary development - Consumer benefits - Producer benefits 	Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020
Marketing	<ul style="list-style-type: none"> - Consumer preferences - Communication 	Michalek, Feinberg, & Papalambros, 2005
Content marketing	<ul style="list-style-type: none"> - White papers - Webinars - Case studies 	Goldstein Group Communication, (2024).
Technical sales skills	<ul style="list-style-type: none"> - Sales skills (market analysis, customers' needs, financing, etc) - Social skills (meeting new people, cultural issues, etc) 	Bumblauskas, Carberry, & Sly, 2017
Market demand	<ul style="list-style-type: none"> - Identifying customer needs; - Analyzing competitor offerings; - Adapting to technological advancements; - Incorporating feedback and iteration; - Consumer-centric design thinking 	Ivanov, Pavlenko, Evtuhov, & Trojanowska, 2024

The analysis of the existing definitions demonstrated in Table 3, as well as the role of social media in marketing and marketing skills, is depicted in Figure 5.

It should be emphasized that Figure 5 shows engineers' marketing skills only. These skills, as demonstrated in Figure 5, do not include any soft skills, as proposed by a few authors referenced in Table 8.

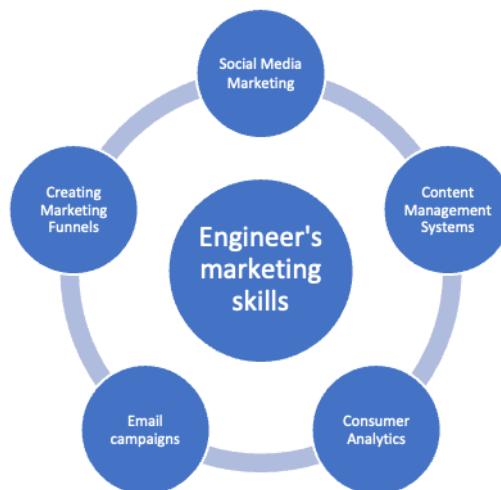


Figure 5 *Engineer's marketing skills (by authors)*

Engineers' marketing skills can be tested before, during, and after implementation of the marketing process to measure marketing success.

2. Empirical Results

The respondents' answers to the online survey are summarized in Table 9. Table 9 presents the frequency and ranking of online survey results.

Table 9 Summary of the respondents' online survey results (the authors)

Survey Question: What marketing skills are important for you?	Frequency	Ranking
Social Media Marketing	159	1
Content Management Systems	95	3
Consumer Analytics	108	2
Email campaigns	40	5
Creating Marketing Funnels	49	4

*Source: Online survey.
n=209*

Respondents' answers demonstrate that social media marketing is the most important engineer's marketing skill, followed by consumer analytics and content management systems.

Discussion

The increasing role of sustainability in engineering innovations and product design allows the introduction of sustainability as the third element in engineering marketing, as depicted in Figure 6.

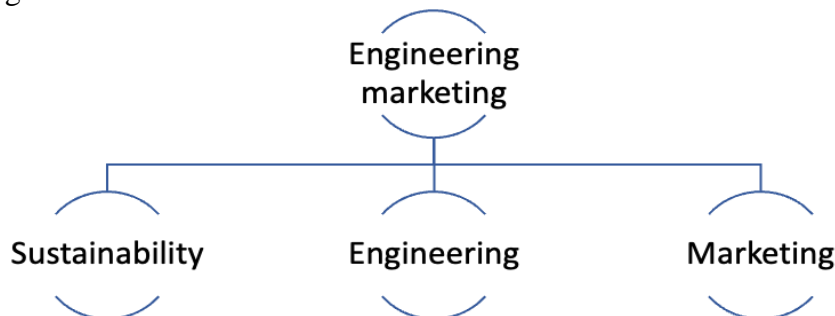


Figure 6 Updated structural elements of engineering marketing (by authors)

Sustainability is an outset for engineering innovation and product design. Sustainability in the process of product creation, manufacturing, repair, and other relevant procedures is characterized by

- material selection for the product to be created,
- energy efficiency in the process of the product manufacturing,
- product recyclability, and
- end-of-life disposal of the product, etc.

Consequently, sustainability affects product market success. Therefore, the focus in engineering innovation and/or product design is no longer on customer preferences. Adding sustainability to the structural elements of engineering marketing also requires the needs of (Ahrens & Zašcerinska, 2012)

- society,
- environment, and
- economy.

Sustainability enhances the importance and relevance of engineers' marketing skills in product design. Owing to the increasing significance of engineers' marketing skills in product

design, more attention should be paid to research in this field, as there is currently a lacuna of scientific efforts to study engineers' marketing skills.

It has to be noted that there is a lack of published research works on engineer's marketing skills. For example, the research published by Lyubanova, Shcherba, Lisitsin, & Oleynikova (2020) emphasized the role of "Engineering Marketing" study course in raising the prestige of market-minded engineers in the context of digital economy.

The existing scientific literature does not provide a clear understanding of engineers' marketing skills. Interesting is that, in a couple of published research contributions, soft skills are part of engineer's marketing skills (Michalek, Feinberg, & Papalambros, 2005; Bumblauskas, Carberry, & Sly, 2017; Lyubanova, Shcherba, Lisitsin, & Oleynikova, 2020).

Moreover, it should be noted that engineers' marketing and technical sales skills differ. Technical sales skills belong to market representatives who sell technical products, while the interest of this research is in engineers and their marketing skills.

The present work elaborates engineers' marketing skills for those who work with computers. Marketing skills for engineers from mechanical, medical, construction, electrical, and other fields may have different sub-skills.

Furthermore, our empirical study points out that social media marketing is the most important skill for engineers who represent the digital economy. Engineers from other engineering fields may arrive at different results. As only a few studies are available via Google searches, comparative analysis cannot be implemented.

Conclusions

Engineers' marketing skills are an emerging research area. More attention should be paid to this topic as engineering enables the sustainable development of the planet and the world. Therefore, collecting experiences and opinions from theorists, practitioners, learners, and stakeholders could help engineers to promote a more sustainable life. Engineers' marketing skills deserve significant attention from the research community.

The results of this empirical study allow us to conclude the importance of social media marketing skills for engineers who represent the digital economy.

The current research was limited by several factors. The theoretical limitations refer to a general lack of scientific literature on this topic. The existing definitions are not clear enough to define engineers' marketing skills. The differences between engineers' marketing and technical sales skills are explained in the available scientific literature. Our empirical study is limited by the number of respondents who participated in the online survey. Another limitation is that the respondents represented only one engineering field in one country. The comparative analysis of our empirical study results was limited by the non-existence of other similar empirical studies on the topic.

Future work will reflect the analysis of literature collected not only via google search. Research will use other sources of literature supported by the concept of open science. Future research should increase the number of respondents and widen the engineering field to which respondents belong. The participation of other countries in future empirical studies is highly appreciated. This would also be beneficial for a comparative analysis of engineers' marketing skills.

Acknowledgement

The presented work has been carried out within Project NPHZ-2023/10068 "STEMify Your Classroom: STEM Platforms for Quality Education" supported by Nordplus Horizontal 2023.

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