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SYNERGY OF ENGINEERING MANAGEMENT AND DIGITAL MARKETING IN THE PRODUCTION OF PAVING TILES

СИНЕРГІЯ ІНЖЕНЕРНОГО МЕНЕДЖМЕНТУ ТА ЦИФРОВОГО МАРКЕТИНГУ У ВИРОБНИЦТВІ ТРОТУАРНОЇ ПЛИТКИ

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Татаринцева Ю., Кривобок Р., Кудій М., Геворкян Е. Синергія інженерного менеджменту та цифрового маркетингу у виробництві тротуарної плитки. Оглядова стаття.

Ця стаття присвячена вивченню синергії між інженерним менеджментом і цифровим маркетингом у виробництві тротуарної плитки, зокрема для таких інноваційних продуктів, як блискуча тротуарна плитка. Інженерний менеджмент забезпечує високі стандарти дизайну, виробництва та контролю якості, тоді як цифровий маркетинг відіграє вирішальну роль у залученні споживачів та підвищенні обізнаності про інновації. Мета цієї статті – дослідити синергію між інженерним менеджментом та цифровим маркетингом, зокрема в контексті розробки та просування інноваційних продуктів, таких як блискуча плитка. У статті також обговорюються переваги синергетичного підходу, що поєднує інжиніринг та цифровий маркетинг для швидкої адаптації до мінливих споживчих запитів та вподобань. Розробка таких інноваційних продуктів вимагає не лише технічних, але й маркетингових зусиль для забезпечення їх успішного виведення на ринок.

Ключові слова: інженерний менеджмент, цифровий маркетинг, тротуарна плитка, інновації, блискуча плитка, маркетингові стратегії, плиткова промисловість, продуктивність, синергія, розробка продукту

Tataryntseva Yu., Kryvobok R., Kudii M., Hevorkian E. Synergy of Engineering Management and Digital Marketing in the Production of Paving Tiles. Review article.

This article focuses on studying the synergy between engineering management and digital marketing in the paving tiles industry, particularly for innovative products like shining paving tiles. Engineering management ensures high standards of design, production, and quality control, while digital marketing plays a crucial role in engaging consumers and raising awareness about innovations. The purpose of this article is to explore the synergy between engineering management and digital marketing, specifically in the context of developing and promoting innovative products such as shining tiles. The article also discusses the advantages of a synergistic approach combining engineering and digital marketing for quick adaptation to changing consumer demands and preferences. The development of such innovative products requires not only technical but also marketing efforts to ensure their successful market introduction.

Keywords: engineering management, digital marketing, paving tiles, innovations, shining tiles, marketing strategies, tile industry, productivity, synergy, product development

The synergy between engineering management and digital marketing has become increasingly important in today's competitive industries, especially in the paving tiles sector. The development and promotion of innovative products, such as shining paving tiles, require an integrated approach that combines technical expertise with effective marketing strategies. Engineering management ensures the efficient design, production, and quality control of these products, while digital marketing plays a crucial role in creating brand awareness and driving customer engagement. Despite the significant potential, there remains a gap in fully leveraging the combined strengths of these two disciplines. As consumer demand for innovative and aesthetically pleasing paving solutions rises, the need for a comprehensive strategy that merges engineering and marketing becomes even more critical. This article aims to explore the potential of this synergy in overcoming current challenges and driving growth in the paving tiles industry, highlighting the importance of addressing these issues to stay competitive in the market.

Analysis of recent research and publications

It is known that the level of energy consumption in the world is increasing every year [1], and increasing energy efficiency will contribute to energy conservation and the creation of a low-carbon environment [2, 3]. Recently, many researchers have shown significant interest in the field of luminescent materials. Luminescent materials can absorb and store

light energy when excited by sunlight or artificial light sources, and then slowly release it in the form of light over time. It should be noted that luminescent materials can be used: for markings on the pavement, applying to road signs and signposts, marking road structures; for decoration; in landscape design, and much more [4]. Shining paving tiles are an excellent example of the innovative use of electrical solutions in the construction industry aimed at saving energy. These tiles are made of materials that can accumulate sunlight during the day and release it at night, providing lighting without additional electricity consumption. This technology not only reduces electricity costs, but also decreases the environmental impact as it reduces the need for traditional lighting sources. The life cycle of fluorescent tiles affects the environment through resource consumption and emissions at all stages – from raw material extraction to disposal.

For example, the authors of [5] created a self-luminous magnesium phosphate cement, a new innovative energy-efficient material that combines a long-term luminescent material and magnesium phosphate cement. It can be used as a new type of beautiful, energy-saving, and environmentally friendly material for exterior wall paving. This innovation not only enhances the aesthetic appeal of urban spaces but also improves nighttime visibility, contributing to public safety. Moreover, the integration of digital marketing strategies can facilitate the promotion of such advanced materials to a broader audience, increasing market adoption. Engineering management plays a crucial role in optimizing production processes, ensuring the material meets quality standards while maintaining cost efficiency. The synergy between engineering management and digital marketing accelerates the commercialization of innovative materials, fostering sustainable development and technological progress.

The potential use of luminophores for creating cement-based composite materials has been studied by many scientists from around the world, for example, Wiese created a luminescent sealant for concrete, and Wong A. and others presented a potential way to use phosphorescent materials with natural rubber used for road materials [4]. These studies highlight the growing interest in developing sustainable and energy-efficient construction solutions. The application of luminescent materials in concrete and road surfaces can improve visibility at night, reducing the need for artificial lighting and lowering energy consumption. Furthermore, combining advanced material science with effective digital marketing strategies can accelerate the adoption of these innovations in the construction industry. Engineering management ensures the efficient scaling of such technologies while maintaining quality and regulatory compliance. This interdisciplinary approach fosters innovation and supports the global shift toward environmentally responsible infrastructure.

The authors [5] have developed a composition of concrete mix for the manufacture of shining paving tiles and paving stones, the materials of which it is made will have low water absorption, high strength,

and luminescent glow. Based on this patent, the authors of the development have created a startup called "Luofor," which is now planned to be launched on the Ukrainian market. This innovative product aims to enhance urban landscapes by offering durable and energy-efficient paving solutions. The luminescent properties of the tiles improve visibility in low-light conditions, contributing to both safety and aesthetic appeal. The combination of advanced engineering processes and strategic digital marketing will play a key role in successfully introducing "Luofor" to consumers. This initiative reflects a broader trend toward sustainable construction materials and supports the modernization of public infrastructure.

Unsolved aspects of the problem

One of the previously unresolved aspects of the overall problem is the integration of engineering management with digital marketing strategies in the paving tiles industry. Specifically, there is a lack of a cohesive framework to combine engineering expertise with effective marketing techniques, which has hindered the optimization of both production and promotion processes. The role of digital marketing in driving customer awareness and engagement for innovative products, like shining tiles, remains largely unexplored. Additionally, adapting engineering management practices to keep pace with digital marketing advancements is a challenge that has not been fully addressed. This article aims to bridge these gaps by exploring how a synergy between engineering management and digital marketing can lead to more successful product development and market penetration in the paving tiles sector.

The purpose of this article is to study the synergy of engineering management and digital marketing in the paving tiles industry with a focus on the development and promotion of innovative products - shining paving tiles.

European innovation ecosystems in the renewable energy sector are promoting the introduction of new technologies [6], such as luminescent paving slabs and green smart building materials [7, 8]. New models of evolution allow us to explore the mechanisms of joint innovation in the field of Construction 5.0, which contributes to the development of a sustainable environment [9]. These ecosystems foster collaboration between research institutions, startups, and industry leaders to accelerate the commercialization of cutting-edge materials. Luminescent paving slabs, for instance, not only reduce energy consumption but also align with smart city initiatives by enhancing urban infrastructure. Digital marketing plays a crucial role in raising awareness and driving consumer adoption of these advanced products. Meanwhile, engineering management ensures the effective integration of new technologies into large-scale production processes. This holistic approach supports the European Union's broader goals for sustainable development and technological innovation.

The modern paving tiles industry faces numerous challenges, among which are the optimization of production processes and effective product promotion

on the market. The synergy of engineering management and digital marketing allows paving tile manufacturers to increase the quality and efficiency of their products, as well as improve communication with customers. Marketing of the impressions plays a special role in the promotion of shining paving tiles, as it allows to highlight its unique properties and aesthetic attractiveness [10, 11]. The integration of these two areas contributes to a rapid reaction to changing market needs, the implementation of new technologies in production processes, and the use of consumer data for further product improvement, which provides sustainable development and competitiveness in the market.

The article is aimed at studying the influence of the integration of these two aspects on the optimization of production processes, increasing economic efficiency, reducing energy consumption, as well as analyzing the effectiveness of digital marketing strategies using to achieve competitive advantages and meet the needs of modern consumers. The main tasks include assessing the technological and commercial aspects of implementing shining tiles, studying feedback from target consumer groups, and formulating of recommendations for further research and development of innovative products in the construction industry.

The main part

The problem is the almost complete lack of affordable, high-quality building materials on the markets which could contribute to the modernization and improvement of comfort in modern cities and villages in Ukraine and other countries. The engineering management process for the production of shining paving tiles includes product research and development, design and engineering, production and manufacturing, quality control, production process management, marketing and sales, as well as after-sales service. Engineering management is concerned with the development of paving tiles, especially when it comes to the introduction of new technologies, materials, or processes into production. Engineering management in this context covers the management of processes and resources to optimize the quality, cost, and time of paving tiles production.

Effective engineering management enables the integration of innovative materials, such as

luminescent components, to enhance the functional and aesthetic properties of paving tiles. This process involves not only improving product durability and environmental resistance but also ensuring compliance with industry standards and customer needs. Additionally, the collaboration between engineering management and digital marketing accelerates the promotion of new paving tile technologies to target audiences. Strategic marketing campaigns can highlight the benefits of advanced paving solutions, facilitating their adoption in both urban and rural areas. Through continuous process optimization and innovation, engineering management contributes to the development of sustainable and modern urban environments.

Therefore, engineering management in the context of paving tiles development can be key to achieving success in this field by helping to solve technical and production problems with efficient use of resources. It allows for the systematic implementation of new technologies and materials while maintaining a balance between cost, quality, and production speed. By optimizing workflows and resource allocation, engineering management ensures that innovative paving tiles meet market demands and industry standards. Moreover, it facilitates the rapid adaptation to new challenges, such as environmental regulations or changing consumer preferences. When combined with digital marketing strategies, engineering management enhances product visibility and accelerates the adoption of advanced paving solutions. This integrated approach is essential for driving sustainable growth and maintaining a competitive edge in the construction materials industry.

Research involves analyzing the market and competitors to determine of the customer needs and develop a product concept. Production includes molding, casting, coating, and assembly processes. Quality control involves systematic testing of products and identification of possible defects. Production process management provides coordination of the work of various departments and teams. Marketing and sales activities include strategy development, advertising campaigns, and cooperation with distributors, including digital marketing. After-sales service includes customer support and complaint resolution.

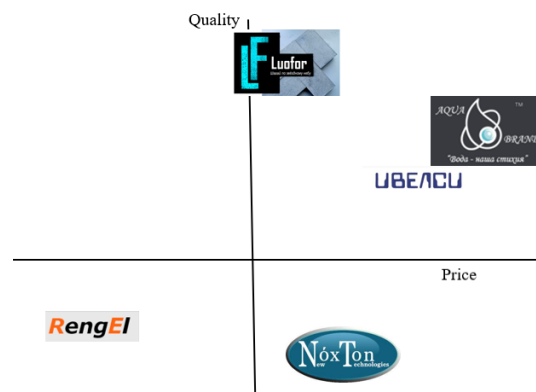


Figure 1. Competitors' analysis of the brand "Luofor"
Source: the authors' own elaboration

Shining paving tiles have a number of advantages that make them an attractive choice for use in construction. Installation of the tiles is simple and practically no different from laying regular paving tiles. Consumers can choose the color of the glow, including green, orange, blue, red, pink and yellow. The duration of the tiles' glow at night is up to 7.5 hours, and they do not require additional energy consumption for operation. The wide range of tiles comes in a variety of shapes and sizes and is characterized by high resistance to external factors and aggressive environments. Competitors' analysis is shown in Fig. 1.

The main indicators of the economic efficiency of shining paving tiles production are presented in Table

Table 1. The indicators of the economic efficiency of shining paving tiles production

| Indicator Name | Value |
|--|-----------------------|
| 1. Planned production capacity, m ² /year | 4050 |
| 2. Revenue from sales, thousand UAH | 53 454,06 – 87 929,70 |
| 3. Price, UAH/item | 250 - 425 |
| 4. Production profitability, % | 101 – 163,84 |
| 5. Product profitability, % | 67,49 – 64,84 |
| 6. Project payback period, years | 0,39 |

Source: the authors' own elaboration

Shining paving reduces heat load more effectively than traditional materials such as concrete and asphalt due to its reflective properties. It is usually more expensive to manufacture and install, but can have a longer life thanks to a special coating that protects against wear. Traditional materials are more affordable, but reflect heat less effectively and can be damaged by climatic conditions. The durability of shining paving and the requirements for its care can vary significantly depending on environmental conditions, such as exposure to ultraviolet radiation, humidity, and mechanical loads, which requires the adaptation of materials and technologies to ensure stable operation and preserve its properties. The integration of advanced technologies such as the Internet of Things (IoT) for smart city applications can greatly enhance the functionality and appeal of shining paving, making it not only aesthetically pleasing but also more useful for data collection and urban infrastructure improvement.

1. These indicators are critical for assessing the financial viability and long-term sustainability of the project. Accurate forecasting of production capacity and revenue helps to determine the scale of operations and potential market share. The profitability metrics reflect the efficiency of resource utilization and the competitiveness of the product in the construction materials market. Additionally, the project payback period provides insight into the time required to recover initial investments and achieve financial stability. By integrating engineering management with digital marketing, companies can enhance these economic indicators through optimized production processes and increased market reach.

Furthermore, shining paving can contribute to energy efficiency by reducing the urban heat island effect, which helps to lower ambient temperatures in city environments. This can lead to reduced energy consumption for cooling and improved comfort in public spaces. Engineering management plays a key role in optimizing the production process, ensuring cost-effective implementation while maintaining high product standards. Digital marketing strategies can highlight the technological and environmental benefits of shining paving, increasing consumer awareness and accelerating market adoption. As urban areas continue to evolve, the combination of innovative materials and smart technologies will become essential for sustainable infrastructure development. This holistic approach enhances both the aesthetic and functional aspects of modern cities, supporting long-term urban planning goals.

As a result of our marketing research, we have identified a growing demand for shining paving tiles. The results of the study are presented in Fig. 2.

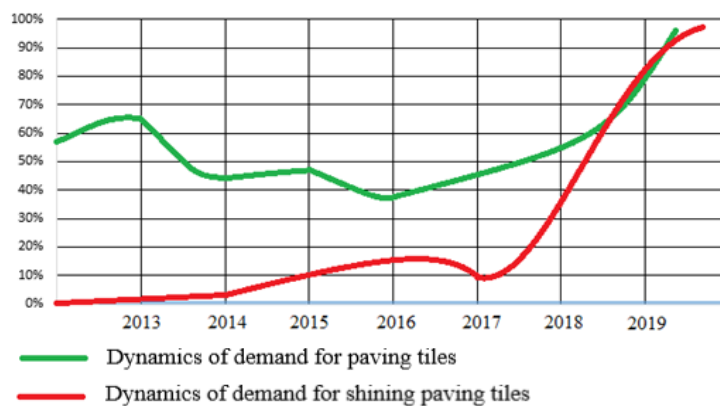


Figure 2. Demand for paving tiles
Source: the authors' own elaboration

We analyzed different groups of the target audience of potential tile consumers. Based on the concept of the economy of impressions [12], it is necessary to study the values of the audience and cause the corresponding impressions and emotions (Table 2). Under impressions are meant emotions that are experienced and remembered by a person as a result of intense feelings that are perceived by the organs of the senses [13]. Managing the impressions of the target audience is a crucial aspect of marketing strategy, as it allows companies to create a strong emotional connection with consumers and enhance brand loyalty.

By understanding the preferences and sensory experiences of different customer segments, businesses can design shining paving tiles that not only meet

functional needs but also deliver unique aesthetic and emotional value. This approach involves using storytelling, visual appeal, and personalized marketing campaigns to evoke positive associations with the product. Digital marketing channels, such as social media and virtual demonstrations, are effective tools for managing impressions and shaping consumer perceptions. Engineering management ensures that product design and manufacturing align with the desired emotional impact, combining technical innovation with customer-centric solutions. This integrated strategy enhances customer satisfaction and supports the successful market positioning of innovative paving technologies.

Table 2. Audience groups and emotional responses

| Target audience | Its values | Target emotions | Formation of impressions |
|--|---|--|---|
| Private individuals, owners of private houses | Comfort, coziness, individuality, quality | Satisfaction, calmness, confidence | Emphasizing the uniqueness and quality of the product, creating an image of comfort and individuality |
| Enterprises | Efficiency, innovation, economic benefit | Success, dynamics, sense of control | Emphasize the benefits of the product in business development, demonstrate innovation and efficiency |
| Hotel and entertainment complexes | Luxury, rest, exclusivity | Excitement, pleasure, relaxation | Creating an atmosphere of luxury and comfort, focusing on exclusive services and relaxation |
| Building companies | Reliability, professionalism, quality | Trust, confidence, success | Highlighting the company's experience and reputation, demonstrating the quality and reliability of the product |
| Administrations of cities and regional centers | Development, convenience, green energy | Positive attitude, pride, responsibility | Highlighting the benefits of environmentally friendly and innovative products, focusing on promoting development and supporting of the city |
| Educational institutions | Education, development, stability | Interest, gratitude, inspiration | Presentation of the product as a way to stimulate learning and development, focus on sustainability and inspiration |

Source: the authors' own elaboration

Developing a digital marketing strategy is a key step in achieving success in marketing campaigns. This strategy involves a systematic approach for choosing the best marketing tools and channels, as well as defining specific action scenarios to achieve the set goals. In this study, we explore the development of digital marketing strategies for different target audiences.

One of the key components of the strategy is the choice of digital marketing tools. These tools can include websites, social networks, contextual advertising, email newsletters, and others. Each of these tools has its own unique opportunities and can be effective in achieving specific marketing goals.

For example, social networks can be used to attract new customers and engage with existing audiences due to their wide audience and targeting possibilities. On the other hand, contextual advertising can be effective in drawing attention to a product or service by placing advertisements on websites and search systems.

After choosing the tools, it is important to set specific success metrics and measure the effectiveness of the campaign. This allows you to analyze the results and make the necessary corrections to achieve the

maximum effect. To add ways to create impressions to your digital marketing strategy, you can use the following techniques:

1. Use of visual elements: create attractive and aesthetically engaging images, videos, and graphics on the website, in advertising banners, and on social networks. This will help promote a positive brand perception.

2. Optimize the user experience: provide a user-friendly and intuitive interface on the website, mobile applications and other digital platforms. This will allow users to easily find the information they need and make purchases without unnecessary obstacles.

3. Interaction with the audience: creating opportunities for feedback and active communication with customers through the website, social networks and email. This will help build long-term relationships with customers and increase their loyalty to the brand.

4. Content personalization: providing users with individualized information and offers based on their interests, previous purchases, and online behavior. This will allow you to create a personalized experience for each user and increase the likelihood of a successful conversion.

These methods allow to enhance the experience of interacting with the brand "Luofor" and its products, which will contribute to a positive perception and increase conversion.

Discussion of the Results. Summarize the digital marketing tools which we recommend for promoting shining tiles:

1. Social media advertising. Advertising campaigns on Facebook, Instagram, or LinkedIn allow you to attract the attention of individuals, summer residents, and homeowners.

2. Search engine optimization (SEO). Optimizing a website for search engines helps to attract the attention of businesses and construction companies who are looking for paving tiles suppliers.

3. Electronic commerce (E-commerce). The development of an online store allows the hotel and entertainment complexes and city administrations to order tiles directly through the Internet.

4. Targeted Google advertising (Google Ads). Advertising campaigns on Google allow you to attract the attention of construction companies and businesses looking for partners in the field of construction and repair.

5. Email Marketing. Sending out emails with product updates and offers helps to keep in touch with customers, even for city and regional administrations.

6. Video marketing. Creating video content that demonstrates that the use of paving tiles can be an effective tool for all target audiences, including individuals, businesses and educational institutions.

We propose to use the grant funds for developing an e-commerce website and spending money on a digital advertising campaign. The grant funds can be used if the project is submitted in a startup format. We predict the following results of the effectiveness of the advertising campaign per month for each of the digital marketing tools: website, social networks, contextual advertising, and email newsletter (Table 3).

Table 3. Indicators of economic efficiency production of shining paving tiles

| Tool | Conversion coefficient | The cost per month, thousand UAH | Conversion income |
|------------------------|------------------------|----------------------------------|-------------------|
| Website | 3% | 5,710 | 1,710 |
| Social networks | 5% | 4,570 | 1,430 |
| Contextual advertising | 5% | 6,860 | 1,140 |
| Email newsletter | 3% | 2,860 | 860 |

Redistributing the advertising budget of up to 20 thousand UAH between different tools allowed us to maintain a balanced marketing strategy, providing coverage of different channels.

Conclusion

This article explores the influence of engineering management and digital marketing on the development of the paving tiles industry, with a particular focus on analyzing the demand for shining tiles. The authors analyzed various management of impression strategies aimed at different target audiences and took into account their unique needs and values.

Special attention was paid to the effectiveness of digital marketing in the context of the paving industry through the analysis of key success indicators. The results of the research allow us to understand which marketing and management strategies can be most effective for different segments of the paving tiles market.

Important aspects of the implementation of digital marketing tools in this industry are highlighted in detail, and opportunities for increasing the competitiveness of companies are identified. It is emphasized that taking into account the individual characteristics of consumers and adapting marketing strategies is a key factor for success in this market segment.

The necessity of further research in this area is substantiated to expand knowledge about the connection between engineering management and digital marketing in the paving tiles production industry. The conclusions of the article highlight the importance of further development and research in this area to improve the efficiency and competitiveness of this industry.

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Abstract

This article focuses on studying the synergy between engineering management and digital marketing in the paving tiles industry, particularly for innovative products like shining paving tiles. It explores how the integration of engineering and marketing strategies can contribute to the effective development and promotion of new products in the market. Engineering management ensures high standards of design, production, and quality control, while digital marketing plays a crucial role in engaging consumers and raising awareness about innovations. The article also highlights the importance of utilizing modern digital technologies to adapt marketing strategies to rapid market changes.

The purpose of this article is to explore the synergy between engineering management and digital marketing, specifically in the context of developing and promoting innovative products such as shining tiles. This study aims

to identify opportunities for improving production and marketing processes in the paving tiles industry. The integration of these two fields remains insufficiently researched, which lowers the competitiveness of companies.

The article also discusses the advantages of a synergistic approach combining engineering and digital marketing for quick adaptation to changing consumer demands and preferences. The development of such innovative products requires not only technical but also marketing efforts to ensure their successful market introduction.

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