

## Article

# Digitalization of Management Processes in Small and Medium-Sized Enterprises—An Overview of Low-Code and No-Code Platforms

Roman Domański , Hubert Wojciechowski , Jacek Lewandowicz \*  and Łukasz Hadaś

Institute of Logistics, Faculty of Engineering Management, Poznan University of Technology, Jacka Rychlewskiego 2, 60-965 Poznań, Poland; roman.domanski@put.poznan.pl (R.D.); hubert.wojciechowski@put.poznan.pl (H.W.); lukasz.hadas@put.poznan.pl (Ł.H.)

\* Correspondence: jacek.lewandowicz@put.poznan.pl

**Abstract:** The permanent digitization of management processes entails, among other things, a need for the automation of the process of making certain business decisions. The aim of the article is to review and evaluate low-code/no-code platforms used, for instance, in small and medium-sized enterprises, available on the Polish IT market. Using a systematic literature review, an assessment of the scale of the discussed issue, involving the number of publications, detailed topics covered, etc., is provided in the theoretical part of the study. During our research, using grey incidence analysis, a ranking of low-code/no-code platforms is created based on the characteristics that they offer. The article highlights the benefits of using new technologies in the form of low-code/no-code platforms in the management of smaller organizations.

**Keywords:** low-code/no-code platform; small and medium-sized enterprises (SMEs); grey incidence analysis (GIA); digitalization of management processes



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## 1. Introduction

A large amount of information and data, in conjunction with time pressure, makes the contemporary management of organizations a difficult undertaking. In the current age of widespread digitization, a key trend of the 21st century, IT technology can help to solve the above issue, as, when properly selected and applied, it can support decisionmakers in the challenges that they face.

Digital transformation has led to a profound change in the way that we think about customer experiences, business models, and operations. It has led to the development of new ways to deliver value, generate revenue, and increase efficiency. Digitization can also be seen as the integration of digital technologies into existing business processes or as the conversion of information and documents from analogue to digital formats [1].

At the outset, an organization should revise their business processes to generate value, eliminating those processes that do not lead to this outcome. Next, an organization should consider which processes do not require excessive or any interference by a decision maker (a human), as these are the ones that should be digitized.

This research topic is important and current, because smaller-sized organizations in particular struggle with low investment budgets and a lack of professional IT competences. The solution is low-code/no-code (LNC) platforms—new technologies in management. They are relatively inexpensive tools that do not require extensive knowledge of computer science. Their implementation allows the improvement of the efficiency of the decision-making process and realization in the management of organizations, translating into an increase in generated added value.

The aim of the article is to review and evaluate low-code/no-code platforms that are used, for instance, in small and medium-sized enterprises and are available on the

Polish IT market. This limits the generalizability of the results, because the national and regional platforms of other countries are not included. The study focuses on small and medium-sized enterprises operating in Poland (geographical scope) and on the IT software (created by both domestic and foreign companies) available on the Polish market—both no-code and low-code platforms (sector scope). As part of the research, the following eight platforms are comparatively assessed (in alphabetical order): Appian, K2, Mendix, Microsoft Power Apps, Oracle Application Express (APEX), Pega BPM, the Salesforce Platform, and Webcon. In our study, we purposefully use grey incidence analysis. It allows for the formulation of objective conclusions based on a relatively small research sample—an alternative to statistical research on a larger sample (which we wish to avoid). Our research goal is the segmentation of low-code/no-code platforms into classes—a quality ranking of this type of software. The key elements here are segmentation criteria, based on which (as references) the level of advancement of a given platform can be determined. This article also answers the research question, “what are the comparative strengths and weaknesses of various low-code and no-code platforms based on average user evaluations in terms of ease of use, flexibility, potential, service and support, and cost efficiency?”

The literature search is based solely on the Scopus database. This might appear to be a limitation, but our previous experiences within the subject of this article allow us to conclude that, in almost all cases, the research results based on the Web of Science core collection database are the same, leading to duplicate results. The literature research in the Scopus database was carried out in March 2023. In each case, phrases were searched for in the following places: title, abstract, and keywords.

The most intriguing aspect of the literature search was related to the relationships between the investigated phrases. The selected phrases were paired via the common parts of both sets using an AND operator. A summary of the interrelationships of the searched terms is presented in Table 1.

**Table 1.** Number of publications on a given topic.

	LNC	LNCP	SME	GST	GIA
LNC		26 (10)	1 (1)	0 (0)	0 (0)
LNCP			1 (0)	0 (0)	0 (0)
SME				23 (8)	5 (2)
GST					322 (155)
GIA					

Source: own development based on the Scopus database (legend: LNC—low/no code; LNCP—low-/no-code platform; SME—small and medium-sized enterprise; GST—grey system theory; GIA—grey incidence analysis (e.g., 26 (10)—the total number of publications, including the number of strictly scientific articles, which is shown in brackets).

The topic of LNC platforms in the context of the LNC trend has already been of some interest to scientists (10 articles). Nonetheless, the use of LNC platforms in the context of SMEs is only now beginning to be discussed and comprises only one article. Moreover, GST has already been applied to SMEs (eight articles). On the other hand, GIA a GST-specific tool—has remained rather niche, with only two articles using these data, although, in general (outside the SME trend), GIA is a fairly popular GST tool (155 articles).

As part of the low-code/no-code literature screening, the substantive analysis excluded 4 out of 10 potential articles, the research areas in these articles were not of direct

interest to the authors of the present article. Table 2 presents a brief description of each of the six scientific articles on LNC platforms, the topic of which is related to the title of this article. It should be emphasized that only one article [2] referred directly to small and medium-sized enterprises.

**Table 2.** List of articles related to low-code/no-code platforms.

Source	Year	Scope of Interest
[2]	2023	The article assesses the understanding of the LNC applications and their scope of use for web design, rapid application development, and supply chain digitization; economical and easy to maintain LNC application development can help SMEs to compete with large organizations.
[3]	2023	The article analyzes the current literature on LNC platforms, with an overview of the platforms and their usability in particular, which factors are the most relevant and how users perceive these tools.
[4]	2022	An expert article comparing low-code approaches (programming platforms), identifying their differences and similarities and analyzing their strengths and weaknesses.
[5]	2022	The article presents CATtalk a platform focused on creating and maintaining interactive works of art; thanks to mechanisms with LNC, artists can manipulate CATtalk with little or no programming effort.
[6]	2022	The article presents project challenges for the integration of business strategy information into a programming method based on Model-Driven Development (MDD) and LNC platforms.
[7]	2021	The article presents the Open Low-Code Platform (OLP) a low-code solution for the creation of applications by inexperienced users.

Source: own development based on the Scopus database.

As part of the topic of the use of grey system theory in small and medium-sized enterprises, the substantive analysis excluded one of eight potential articles (historically outdated). Table 3 presents a brief description of the remaining seven articles, whose content was related to the title of this article. It should be noted here that only one article [8] referred directly to the GIA method.

**Table 3.** List of articles on the use of grey system theory in small and medium-sized enterprises.

Source	Year	Scope of Interest
[8]	2023	The article presents an analysis of the key challenges connected with building resilience in craft SMEs using the Grey Decision-Making Trial and Evaluation Laboratory.
[9]	2022	The article presents the use of grey system models to solve the problems of financing SMEs in the supply chain.
[10]	2021	In the article, the method of fuzzy exponential correlation of greyness is used to assess the quantitative process of industrial production design in the context of SMEs, among others.
[11]	2017	The article presents the use of grey logic to select ERP systems appropriate to the specificity of SMEs.
[12]	2015	The article presents a multi-criteria decision-making model for the selection of an ERP provider for SMEs, based on the effective use of the concept of grey numbers.

**Table 3.** *Cont.*

Source	Year	Scope of Interest
[13]	2014	The article focuses on the course of financial repression and its impact on financing (SMEs) based on the classic GM model.
[14]	2014	In the article, based on GST, using the method of grey relational analysis, the effectiveness of the internal control of quoted companies in the context of financing SMEs is examined.

Source: own development based on the Scopus database.

In addition to the article [14] on the use of the GIA method in SMEs (mentioned in Table 3), a dedicated search devoted to this method led to the identification of another article [15]. This article explains the relationship between income inequality and financial gaps in relation to SMEs, using grey relational analysis as a methodological tool.

Using a systematic literature review, an assessment of the scale of the discussed issue, the number of publications and the detailed topics considered was carried out in the theoretical part. The results of the literature research (in the way that the topic is approached) showed that there is a clear gap related to LNC platforms, particularly in the context of SMEs (only six publications, generalized). Among these publications, only one analyzes this topic in the context of small and medium-sized enterprises (the aspect of supply chain digitization), further emphasizing the niche nature of the topic—see Table 2. The results of the literature research (methodological approach) show that there is a clear gap in the application of grey system theory among small and medium-sized enterprises, particularly in problem solving (only seven publications on grey models, logic, and numbers). Among these publications, in the context of small and medium-sized enterprises, only two use the grey relational analysis method (both in terms of financing SMEs) [14,15], again emphasizing the topic as a niche—see Table 3. To summarize, the originality of this article consists of (1) expanding the knowledge of low-code/no-code platforms in the context of small and medium-sized enterprises (filling the quantitative gap, by providing another article on this topic, and the qualitative gap, by offering not a general but a detailed analysis of this topic); (2) solving the problem of assessing the importance of platforms' features using GIA, a method from the GST family, as an innovative methodological approach (filling the quantitative gap, by providing another article on the topic, and the qualitative gap, as, so far, GIA has not been used to assess low-code/no-code platforms). The aim of the article is to perform a comparative assessment of the LNC platforms used, among others, in SMEs. As a result, a ranking of platforms' characteristics is created. The final assessment results of low-code/no-code platforms are used to categorize them into three clusters. This allows us to obtain a list of the features and functionalities of the low-code/no-code platforms preferred by users from SMEs.

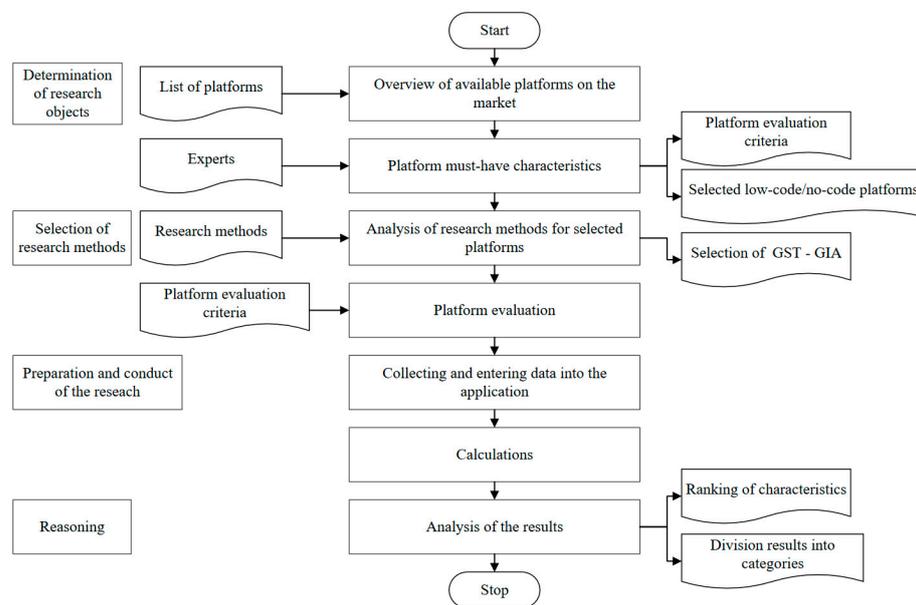
The article consists of the following parts: a systematic review of the literature, a description of the research methodology, the presentation of the results, and a summary with conclusions. In light of previous research focused on creating a ranking of CRM systems using grey system theory [16], the authors follow this thread of research interest with this article.

## 2. Materials and Methods

In today's rapidly evolving digital era, businesses are perpetually seeking methods to optimize and automate their operations. This quest for operational efficiency has steered numerous organizations toward low-code platforms, which offer a promising avenue for the development of business applications. These platforms, notable for their accessibility, empower individuals—irrespective of their coding acumen—to design, deploy, and manage business applications tailored to their unique needs. The pivot toward these platforms has ignited a spark of curiosity, prompting this research to delve deeper into the comparative nuances between popular low-code platforms. The primary aim of this research is to

illuminate the disparities in the functionalities proffered by different platforms and gauge their resonance with the requirements of SMEs.

The meticulously crafted research methodology presented by the authors is grounded in a systematic four-phase approach, as depicted in Figure 1. Each step, taken sequentially, ensures comprehensive insights into the evaluation and analysis of low-code platforms.



**Figure 1.** Research methodology.

#### 1. Determination of research objects:

The cornerstone of this research is the thorough examination of low-code platforms. As the first step, the team delineated the scope of study by specifying these platforms as the primary “research objects”. In doing so, they established a clear benchmark, ensuring that the entire study revolved around a focused analysis of these pivotal tools.

#### 2. Selection of research methods:

Before the assessment of the platforms, it was essential to anchor the study in a robust analytical framework. This phase was devoted to a rigorous review of a range of potential research methodologies. The objective was to select a method that did not only resonate with the study’s aims, but also promised an exhaustive insight into the intricacies of each platform. After intense deliberation, a specific research technique was selected, providing the study with a firm analytical basis.

#### 3. Preparation for and performance of the research:

Once the method was established, the selected low-code platforms were subjected to real-world testing. The study started on 1 April and ended on 30 June 2023. The short duration of the study was beneficial, because no significant updates to any of the platforms were released. To ensure an unbiased, hands-on analysis, the authors sought the expertise of actual users of these platforms. These users interfaced with the platforms by implementing a simple IT application that the authors had prepared specifically for this assessment. The preparation of the application served a dual purpose. Firstly, it provided a standardized tool for evaluation, thus ensuring consistency across all assessments. Secondly it provided the users with a practical challenge, eliciting genuine feedback rooted in real-world application.

#### 4. Reasoning:

The culmination of the research resides in the pivotal phase. During this part, all of the data gathered from the user assessments were pooled together, sorted, and subjected

to rigorous analysis. While the nuances of this phase, including the detailed results and interpretations, will be unfolded in subsequent sections of the article, it is here that the strengths, potential gaps, and unique facets of each low-code platform emerge.

In essence, this structured, four-step approach ensured a well-rounded, in-depth exploration of low-code platforms, paving the way for actionable insights and informed decisions for businesses seeking to leverage these tools.

The grey incidence analysis (GIA) method, while useful in many contexts, does have potential biases and limitations, particularly when applied to evaluating complex digital platforms. Below are some key points that were considered before choosing this method and a list of the criteria:

- **Data Sensitivity and Reliability:** GIA heavily relies on the quality of the input data. In the context of digital platforms, the data can be vast, varied, and sometimes inconsistent. Any inaccuracies or incompleteness of the data can significantly skew the results, leading to unreliable conclusions.
- **Subjectivity in Factor Selection:** The choice of factors (variables) that are analyzed in GIA is subjective. In evaluating digital platforms, the omission of relevant factors or the inclusion of less significant ones can bias the outcome. The method does not inherently account for the relevance or weight of different factors, which can be crucial in complex digital environments.
- **Linear Assumptions in a Non-Linear Context:** GIA often assumes a linear relationship between variables. However, digital platforms often operate in a highly dynamic and non-linear environment, where interactions between variables are complex and not easily quantifiable through linear methods.
- **Oversimplification of Complex Relationships:** GIA simplifies the relationships between variables to a single degree of incidence. This simplification can be a significant limitation in digital platforms, where the relationships between variables are multifaceted and influenced by a myriad of external and internal factors.
- **Lack of Contextual Analysis:** GIA primarily focuses on a numerical relationship between variables, often overlooking the qualitative aspects. In digital platforms, contextual factors like user behavior, market trends, and technological advancements play a crucial role in the determination of the platform's success or failure.
- **Inadequate for Predictive Analysis:** While GIA can provide insights based on existing data, it is not inherently predictive. In the rapidly evolving digital landscape, the ability to forecast future trends and the adaptability of platforms is crucial, which GIA might not adequately address.
- **Difficulty in Handling Big Data:** Digital platforms often generate vast amounts of data. GIA, traditionally, may not be well suited to handling such big data efficiently, potentially leading to oversights or errors in analysis.
- **Cultural and Contextual Biases:** When evaluating global digital platforms, GIA might not fully account for the cultural and regional differences that can significantly influence user interaction and platform effectiveness.
- **Change Over Time:** Digital platforms are subject to continuous evolution. The static nature of GIA might not capture the dynamic changes over time effectively, leading to outdated or irrelevant findings.
- **Interdependence of Factors:** In digital platforms, factors are often interdependent. GIA's typical approach of analyzing the factors in isolation may not capture these interdependencies accurately, leading to a distorted understanding of the platform's functionality and user experience.

In summary, while grey incidence analysis can be a valuable tool, its application in the complex and dynamic environment of digital platforms requires the careful consideration of these potential biases and limitations to ensure valid and useful insights. With this in mind, the authors decided to limit the research period and take into account a relatively short list of criteria.

### 3. Results and Discussion

In this section, the authors present the results of a comparative analysis of the LNC platforms used in small and medium-sized enterprises (SMEs). The study aimed to evaluate and compare the functionalities offered by different solution providers, as well as assess their significance for users in the SME sector. The authors conducted an extensive evaluation, considering various characteristics and features of these platforms. The experts who participated in the study came from SMEs. They were both users and IT implementation experts. The tools (platforms) for the development of business applications offer easy and quick ways to build apps without having to write code. Thanks to them, users can create business applications using ready-made modules and templates, which allows them to automate business processes and integrate them with other systems. All platforms offer unique features and functionalities, so the users can choose the tool that best suits their needs and requirements.

For this purpose, research was carried out on the Internet, based on the rankings of platforms published, including

- <https://www.peerspot.com/categories/business-process-management-bpm> [17];
- <https://www.gartner.com/reviews/market/business-process-automation-tools> [18];
- <https://www.g2.com/categories/low-code-development-platforms> [19];
- <https://www.pcmag.com/picks/the-best-low-code-development-platforms> [20].

It also included the websites of individual platform developers. Based on the lists of the platforms available on the market, all those that were dedicated only to large enterprises were rejected. Additionally, a group of experts utilizing low-code and no-code platforms in their work were invited to indicate which system characteristics they considered essential. Platforms lacking these characteristics were rejected. Reasons that led to the rejection of the platforms were as follows.

- Too high complexity: if a platform is too complex to learn and use among non-programmers, it may not fulfill its basic task as a low-code/no-code tool.
- Lack of scalability: small and medium-sized enterprises often expect rapid growth—if a platform is unable to be scaled with a business, it may be the wrong choice.
- Insufficient integration possibilities: many companies use different systems and tools—if a low-code/no-code platform does not allow easy integration with the existing technological ecosystem, this may be a reason for rejection.
- Lack of flexibility: sometimes, low-code/no-code platforms can be too limited, making it impossible to adapt the application to the specific needs of a company.
- Safety and compliance: if a platform does not meet safety standards or regulatory requirements, this can be a serious problem.
- Costs: the cost of a platform may be too high, especially if additional costs such as training, maintenance, extension, etc., are taken into account.
- Technical support and community: the lack of solid technical support or an active community of users can make a platform less attractive.

The assessment of system users (average) included such factors as ease of use, system flexibility, system potential, the additional services and support of the developer, and the operating costs.

#### 3.1. Ease of Use: Essential for User Engagement and Efficiency

A tool's ease of use is paramount, particularly for those lacking programming expertise. This criterion does not merely refer to the basic functionality; it encompasses a holistic approach to the user experience. Business platforms that excel in this area typically offer a range of user-friendly features.

- Intuitive User Interfaces: The interface should be straightforward, minimizing the learning curve for new users. This includes clear labels, logical navigation, and the consistent design of elements to make the platform approachable and easy to understand.

- **Drag-and-Drop Functionality:** This feature allows users to interact with the platform in a more tactile and visual manner, simplifying complex processes. It is especially beneficial in tasks like organizing data, customizing layouts, and managing content, making the platform more accessible to non-technical users.
- **Customizable Templates and Modules:** Templates provide a starting point for various tasks, saving time and effort. Modules, or pre-built components, can be assembled in different combinations, offering flexibility while maintaining ease of use. These features cater to a diverse needs and skill levels, enabling users to create or modify content without starting from scratch.

### 3.2. Evaluating Ease of Use

To thoroughly examine this aspect, a combination of practical tests and user feedback is essential.

- **User Experience Tests:** These involve the observation of users as they interact with the platform, identifying any hurdles or points of confusion. This hands-on approach provides direct insights into the user journey, highlighting the areas for improvement.
- **Surveys and Feedback:** Soliciting feedback through surveys or questionnaires gives users a voice, offering valuable perspectives on their experience. Questions can be tailored to gauge users' satisfaction with the interface, the understandability of features, and the overall efficiency of the platform.

### 3.3. Focus of the Study

The study aimed at assessing ease of use focused on several key elements.

- **User Interface Intuitiveness:** How instinctive is the navigation? Are the features and tools easily discoverable?
- **Speed and Performance:** Does the platform perform tasks quickly and efficiently? Are there any lags or loading issues that hinder the user experience?
- **User Satisfaction:** How do users feel about their interactions with the platform? Is it meeting their expectations, in terms of simplicity and functionality?

By delving into these details, the ease of use of a business platform can be comprehensively evaluated, ensuring that it meets the needs of a diverse user base, including those without programming experience.

### 3.4. Flexibility: Customization and Adaptability for Diverse Business Needs

The flexibility of a platform signifies its ability to be adapted and aligned with the varying needs of different businesses. This adaptability is crucial in a dynamic business environment where requirements can shift rapidly. Business platforms excelling in flexibility often share certain characteristics.

- **Broad Range of Functionality:** These platforms provide a wide array of features and tools, catering to a spectrum of business operations. This includes diverse data management options, communication tools, analytical capabilities, and more, allowing businesses to select and use the functionalities most relevant to them.
- **Customization Options:** The ability to tailor applications to specific business requirements is a key aspect of flexibility. This might involve modifying workflows, creating custom reports, or adjusting user interfaces to better suit the specific processes and preferences of a business.
- **Modular Design:** Offering modular components that can be added, removed, or modified enables businesses to build a platform that grows and changes with their needs. This approach allows for incremental changes without overhauling the entire system.

### 3.5. Assessing Flexibility

To evaluate the flexibility of a platform, a thorough examination of its adaptability and customization options is necessary.

- **Adaptation to Business Needs:** Assesses how the platform can be adjusted to fit unique business processes. This involves looking at how workflows can be customized, whether the platform can handle varying data types and volumes, and whether it can be integrated with existing business tools.
- **User-Centric Customization:** Determines the ease with which users can modify the platform. Considers whether users can easily change settings, customize dashboards, and create user-defined fields without extensive technical knowledge.
- **Scalability:** Considers how well the platform can scale as the business grows. Does it support an increasing number of users, more complex workflows, or larger data sets without a decline in performance?

### 3.6. Conducting a Study

To gain in-depth insights into a platform's flexibility, a study focusing on the following aspects was conducted.

- **Availability and Diversity of Features:** Examination of the range of features offered by the platform and how these can cater to different business operations.
- **Template and Module Availability:** Evaluation of the variety and usability of templates and modules that can be employed to customize the platform.
- **Integration Capabilities:** Assesses how well the platform integrates with other systems and tools, an important factor in maintaining seamless operations across different business applications.

By exploring these elements in detail, one can gain a comprehensive understanding of a platform's flexibility and its suitability to meet varied business requirements.

### 3.7. Potential: Fostering Growth and Evolution in Business Applications

The concept of potential in a tool refers to its capacity for future expansion and development. This forward-looking feature is crucial in the rapidly evolving business landscape, where staying ahead with technology can be a significant competitive advantage. Business platforms that are highly ranked according to their potential typically exhibit several key traits.

- **Scalability of Applications:** These platforms are designed to grow alongside the business. This means that they can handle increased user numbers, larger data volumes, and more complex processes without a decline in performance.
- **Continuous Development Capabilities:** Tools with high potential are not static; they are constantly evolving, with developers actively working on new features and improvements. This ensures that the tool remains relevant and effective in the face of a changing business landscape and technological advancements.
- **Adaptability to Changing Needs:** As businesses evolve, their requirements can change. Platforms with high potential can adapt to these changing needs, whether this means integrating a new technology, accommodating a new business model, or expanding to new markets.

### 3.8. Evaluating Potential

To thoroughly assess a platform's potential, one must look at several aspects.

- **Ease of Development and Expansion:** Examine how easily a new functionalities can be added to the platform. This includes looking at the platform's architecture to see if it supports plug-ins or add-ons, and whether it has a robust API for integration.
- **Update Frequency and Quality:** Regular updates are a sign of a platform's commitment to growth. Assess the frequency and impact of updates and upgrades—do they add significant value, and are they responsive to user feedback and market trends?
- **Long-Term Viability:** Consider the platform's track record and future roadmap. Does it have a history of consistent improvement? Is there a clear plan for future development?

### 3.9. Conducting a Study

A focused study on a platform's potential examines the following areas.

- **Scalability:** How does the platform handle increased operational demands? Insights into its performance under varying levels of stress and its ability to maintain efficiency and reliability as it scales.
- **Availability of New Features and Updates:** Investigation of the history and a forecast of new functionalities to be added. This includes the frequency of updates and the nature of the features added—are they keeping pace with technological advancements?
- **Adaptability to Changing Business Needs:** Assess how the platform has adapted over time to new business trends and user requirements. This can be gauged by looking at case studies or user testimonials to understand how the platform has supported businesses in their growth and adaptation to market changes.

By delving into these aspects, one can gain a comprehensive understanding of a platform's potential to support future business growth and adaptation, ensuring that it remains a valuable asset in the long term.

### 3.10. Service and Support: Ensuring Reliability and User Confidence

Service and support are critical components of any business tool, indicating the quality and reliability of assistance provided to users. High-quality service and responsive technical support are essential in maintaining smooth operations and user satisfaction. Business platforms that excel in this area are known for several key features.

- **Responsive Technical Support:** These platforms provide timely and effective solutions to technical issues. This involves not only addressing problems quickly but also ensuring that the solutions are effective and prevent future occurrences.
- **Comprehensive Service Offerings:** Beyond troubleshooting, exemplary service includes a range of support options like onboarding assistance, regular check-ins, and proactive maintenance. This comprehensive approach helps users to maximize the tool's potential.
- **User-Centric Assistance:** Support services should be tailored to the varying skill levels and needs of the users. This might include the offering of different tiers of support or providing specialized assistance for different aspects of the platform.

### 3.11. Evaluating Service and Support

To accurately assess a platform's service and support quality, several factors should be considered.

- **Responsiveness and Effectiveness:** Evaluate how quickly the support team responds to inquiries and how effectively they resolve issues. This can be measured through response time metrics and user satisfaction ratings following support interactions.
- **Range of Support Channels:** Consider the diversity of support channels available, such as email, phone, live chat, and community forums. A variety of channels ensures that users can seek help in the way that suits them best.
- **Quality of Interaction:** Assess the expertise and professionalism of the support team. Are they knowledgeable about the platform? Do they communicate clearly and empathetically?

### 3.12. Conducting a Study

A focused study on service and support will investigate the following areas.

- **Speed and Effectiveness of Technical Support:** Measure of how quickly the support requests are addressed and resolved. This can involve tracking the average response time and resolution time, as well as analyzing case studies of complex support scenarios.
- **Availability of Training and Support Materials:** Examine the range and quality of training resources and supporting documentation. This includes user guides, FAQs,

video tutorials, and webinars. Assess how helpful these materials are in assisting users to understand and use the platform effectively.

- **Quality of Documentation:** Review the comprehensiveness and clarity of the documentation provided. Well-structured, easy-to-understand, and regularly updated documentation is essential for user self-service and problem resolution.

By exploring these elements in depth, one can gain a thorough understanding of a platform's service and support quality, ensuring that it meets the needs and expectations of its users.

### 3.13. Costs: Balancing Affordability and Value in Business Tools

Costs are a critical factor in the selection of business tools, emphasizing the need for affordability without compromising on quality and functionality. The ideal tool provides optimal benefits at a minimal cost, aligning with budget constraints while delivering significant value. Business platforms that stand out in this aspect often feature the following.

- **Reasonable Pricing:** These platforms offer their services at prices that are justifiable, based on the features and benefits provided. They strike a balance between cost and quality, ensuring that users receive good value for their investment.
- **Flexible Pricing Options:** Flexibility in pricing caters to a wider range of businesses, from startups to large corporations. This may include tiered pricing models, pay-as-you-go options, or customized pricing plans based on specific user needs.
- **Transparency in Costs:** It is important that platforms clearly outline all associated costs, including any potential fees for additional services or functionalities. This transparency helps users to make informed decisions and plan budgets effectively.

### 3.14. Evaluating Costs

When assessing the cost-effectiveness of a platform, several factors are taken into account.

- **Variety of Pricing Options:** Investigate the range of pricing plans available. Are there any options suitable for different sizes and types of businesses? Do the plans offer flexibility to scale up or down based on changing needs?
- **Associated Costs:** Look beyond the base price to understand the full cost of using the platform. This includes additional charges for extra features, support services, integration with other tools, and any maintenance fees.
- **Value for Money:** Evaluate whether the costs align with the value provided. Does the platform offer features and benefits that justify its price? Are there any cost-saving benefits in the long run due to increased efficiency or other advantages?

### 3.15. Conducting a Study

A detailed study on costs covers the following aspects.

- **Availability of Pricing Options:** Analyze the different pricing plans offered and their suitability for various business needs. This includes an examination of the features included in each plan and any restrictions or limitations.
- **Total Cost of Ownership:** Assess the overall cost of using the platform over a significant period, including subscription fees, additional feature costs, and any other recurring expenses.
- **Comparison with Competitors:** Compare the platform's pricing with similar tools on the market. This helps in understanding how the tool's pricing stands in terms of market standards and whether it offers a competitive advantage.

By thoroughly examining these areas, one can gain a comprehensive understanding of a platform's cost structure, ensuring that it aligns with the budget considerations and provides good value for the investment made.

Regarding the selection criteria for platforms in our study, it is important to clarify that our approach was driven by the objective of focusing on the most relevant and widely used platforms in the market. The platforms included in our research were identified based

on their popularity and consistent presence in various industry rankings. This approach was adopted for several reasons.

- **Relevance to a Broad Audience:** By selecting platforms that are popular and widely recognized, our research remains relevant to a larger segment of the business community, including SMEs. These platforms, due to their widespread adoption, provide a more comprehensive understanding of the general landscape.
- **Data Availability and Reliability:** Popular platforms often have more readily available data, user reviews, and comprehensive documentation. This abundance of information allows for a thorough and reliable analysis.
- **Benchmarking Purposes:** Well-known platforms serve as effective benchmarks in the industry. Their features, performance, and market reception set standards against which other platforms can be compared, offering valuable insights into what constitutes success in the market.
- **Feasibility and Scope Management:** Considering every available platform is impractical due to resource constraints. Focusing on the most popular ones helps in managing the scope of the research, ensuring that it is comprehensive, yet feasible.
- **Reflecting Market Trends:** Popular platforms are often indicative of current market trends and user preferences. Analyzing these platforms provides an insight into what businesses are currently valuing and the directions in which market trends are heading.

It should be acknowledged that this approach might limit the scope of research to more mainstream platforms, potentially overlooking niche or emerging solutions. However, the rationale was to provide a representative overview of the market as it currently stands, offering valuable insights for the majority of businesses, especially SMEs. Future research could expand on this by including a more diverse range of platforms, particularly those catering to niche markets or specific business needs.

All these criteria are important and should be taken into account when selecting business application development tools, depending on the individual needs and requirements of the user. The values of individual criteria for each tool were determined during a focused group interview supported by document analysis in this case, they were reports on the rankings of low-code development platform tools.

The selection led to the identification of eight platforms and the completion of step 1—the determination of the research objects, both platforms and their evaluation criteria.

The next step involved the selection of the appropriate research method. Given the complexity of studying LNC platforms in SMEs, the authors, after extensive research and comparisons, decided to use the GIA method from the GST. This choice fit the research assumptions, i.e., a description of reality, a small research sample required, and an unknown distribution of variables.

Preparation for and performance of the research—step 3.

The analysis resulted in values that allowed us to compare both types of platforms (low-code and no-code) and determine which ones are more effective in different application areas. The results of the analysis can help companies and developers to choose the best platform and implement it in their projects.

The first step in this stage is focused on gathering data. It results in the creation of Table 4, where the names of subsequent platforms are placed.  $y_1$  is a characteristic, e.g., the average users' evaluation for a given platform. The scale used in this study is 1–5, where 5 is the maximum positive value. All the other factors from  $x_1$  to  $x_5$  determine the effect on this characteristic. To clarify, for “easy to use” ( $x_1$ ), a value of 5 means that a platform does not require long-term training, it is intuitive, and it is easy to correct any errors; for “costs” ( $x_5$ ), if the cost of operating a platform is high, it is assigned a value closer to 1, and when costs are low, the values are closer to 5.

**Table 4.** Averaged results of expert research.

		Pattern	1	2	3	Platform No.				
			4	5	6	7	8			
Average user evaluation	y1	5	4.1	4.6	4.3	4.5	4.0	4.7	4.4	4.5
Easy to use	x1	5	4.2	4.6	4.5	4.2	4.1	4.5	4.4	4.7
Flexibility	x2	5	4.5	4.8	4.6	4.5	4.2	4.5	4.7	4.8
Potential	x3	5	4.3	4.4	4.6	4.7	3.8	4.7	4.6	4.6
Service and support	x4	5	4.6	4.8	4.8	5.0	4.1	4.3	4.6	4.7
Costs	x5	5	4.5	4.6	4.7	4.7	2.5	3.2	4.8	4.7

Source: own development.

In the next step, the results of the systems were compared against the pattern (column 1) representing the maximum values in each row, which exists only hypothetically and was determined artificially for the purpose of the study. According to the assumptions of GST, the  $S_i$  and  $S_j$  coefficients are used for comparisons. The following formulas are used for the calculation of  $S_i$ ,  $S_j$ , and  $S_j - S_i$  [21]:

$$|s_i| = \left| \sum_{k=2}^{n-1} x_i(k)d2 + \frac{1}{2}x_i(n)d2 \right|, \tag{1}$$

$$|s_j| = \left| \sum_{k=2}^{n-1} y_j(k)d2 + \frac{1}{2}y_j(n)d2 \right|, \tag{2}$$

$$|s_j - s_i| = \left| \sum_{k=2}^{n-1} [y_j(k)d2 + x_i(k)d2] + \frac{1}{2}[y_j(n)d2 - x_i(n)d2] \right|. \tag{3}$$

Table 5 presents the results of processing the data collected in Table 4. In the subsequent columns, the factor ID is presented first, followed by the row-wise sum (sum for x or y), the value from the final row (last for x or y), the outcome of the  $S_j$  calculation for y (appearing in the second row of the  $S_j$ ,  $S_i$  column), and the outcome of the  $S_i$  calculation for each x factor (spanning rows 3 to 7 in the  $S_j$ ,  $S_i$  column). The initial seven columns are utilized to enhance the computations within the application. A section demonstrating accurate partial calculations, which form the core logic of the GIA method, starts from the eighth column.

**Table 5.** Intermediary results of the comparison of each low-code/no-code platform to the master model.

ID	Sum x/y:	Last x/y	$S_i$	1	1	2	3	4	5	6	7	8	9		
y1	-5.8	-0.5	s1	5.55	5	y1	0	-0.9	-0.4	-0.7	-1	-0.9	-0.3	-0.6	-0.5
x1	-6.0	-0.3	s2	5.85	5	x1	0	-0.8	-0.4	-0.5	-0.9	-1.3	-0.4	-0.6	-0.3
x2	-4.8	-0.2	s3	4.70	5	x2	0	-0.5	-0.2	-0.4	-0.8	-1.4	-0.5	-0.3	-0.2
x3	-5.8	-0.4	s4	5.60	5	x3	0	-0.7	-0.6	-0.4	-1.2	-1.5	-0.3	-0.4	-0.4
x4	-4.3	-0.3	s5	4.15	5	x4	0	-0.4	-0.2	-0.2	-0.9	-1.2	-0.7	-0.4	-0.3
x5	-7.0	-0.3	s6	6.85	5	x5	0	-0.5	-0.4	-0.3	-2.5	-0.7	-1.8	-0.2	-0.3

Source: own development.

Drawing from the information in Table 5, the values of  $S_j$  and  $S_i$  were computed, and, subsequently, the absolute difference between  $S_j$  and  $S_i$  was ascertained. This difference highlights the extent of the impact that a specific factor x has on the overall attributes of platform y. The outcomes of these computations are displayed in Table 6.

**Table 6.** Sum of x1–x5 values from the table.

$S_j, S_i$	y1
x1	0.30
x2	0.85
x3	0.05
x4	1.40
x5	1.30

Source: own development.

The epsilon coefficient indicates how much each of the x factors affects the characteristics of platform y, i.e., the average user rating. The following formula was used for the calculation of the epsilon coefficient [21]:

$$\epsilon_{0i} = \frac{1 + |S_0| + |S_i|}{1 + |S_0| + |S_i| + |S_i - S_0|} \tag{4}$$

The final results of the GIA method, after ordering all of the x factors by descending degree of importance, are presented in Table 7.

**Table 7.** Results of epsilon value in descending order.

0.995902	x3
0.976378	x1
0.929752	x2
0.911565	x5
0.884298	x4

Source: own development.

The final part of the research consisted of the preparation of the LNC platform ranking based on the weighted averages that resulted from the GIA method (Table 8). To this end, the factor values presented in Table 6 were combined with the factor weights listed in Table 7.

**Table 8.** Comparison of weighted average and user rating.

Rank		Platform No.
1	0.882939437	8
2	0.871227587	3
3	0.870957644	2
4	0.867612962	7
5	0.86685003	4
6	0.829474326	1
7	0.803017869	6
8	0.703882637	5

Source: own development.

Summarizing the results of the ranking in Table 8, the platforms were divided into the following classes (the authors’ view) based on their average user ratings.

- 1.00–0.85—model platforms. They have a comprehensive infrastructure for the fast and easy creation, testing, and implementation of applications. Often available in both cloud and classic versions, they offer the easy creation of forms and reports, and integration with various data sources; they also have various types of authorization and authentication and modules for the easy management of user rights. These platforms offer ready-made components for use in the designed processes, documentation is available, and support for the user is provided in various channels.
- 0.84–0.80—very good platforms. They offer a fairly comprehensive infrastructure, but they may have some limitations in some areas; they may have fewer modules for the

management of user rights and authorization, and their documentation and support for users may be less extensive or available only in selected channels. They may also offer fewer ready-made components that can be used in application design; however, they still provide the easy creation of forms and reports, and integration with various data sources. They may be available in both cloud and classic versions, but their cloud functionality may be slightly more limited. These platforms offer robust tools for application development, but they may require more work and skill from the user for the best results.

- 0.80–0.70—good platforms. They include basic application development tools such as form editors, report creators, and simple tools for data integration. They are usually available in cloud or local versions, but do not offer as many ready-made modules and components as the best platforms in the ranking. They often lack advanced user rights management tools. The documentation and user support are not always as developed as in the case of highly rated platforms, yet they are still good tools, especially for small businesses or individual developers who need a quick and easy way to create an application without having to write code from scratch.

The results of this analysis shed light on the strengths, weaknesses, and differentiating factors among the platforms, ultimately guiding SMEs in making informed decisions about adopting a suitable LNC solution for their specific needs.

#### 4. Conclusions

The study of low-code/no-code platforms has shown that there are many tools on the market that allow users to quickly create applications without using code or with its minimal use. Thanks to this, users without programming skills can create their own solutions and streamline their business processes. The conducted research also answers the question, “what are the comparative strengths and weaknesses of various low-code and no-code platforms based on average user evaluations in terms of ease of use, flexibility, potential, service and support, and cost efficiency?”. In Table 7, the criteria that have higher values are more important than others; they have a stronger effect on the future development of the platforms and can cause desirable changes in the platforms. Therefore, these criteria need to be strengthened in the following order: potential  $\times 3 >$  easy to use  $\times 1 >$  flexibility  $\times 2 >$  costs  $\times 5 >$  service and support  $\times 4$ . In the ranking of the platforms, the best three platforms are characterized by a comprehensive infrastructure, the easy creation of forms and reports, integration with different data sources, and different types of authorization and authentication. They also offer ready-made components for use in the designed processes. The platforms included in the second segment of the ranking offer many functionalities, but are less popular than the top three. The third segment’s platforms have reduced functionality and are less flexible when creating applications.

The study made use of the grey incidence analysis method, which allowed us to compare the platforms and the weights of individual characteristics. The comparative analysis provides information for companies and organizations that wish to choose the appropriate platform to develop applications with minimal code usage, and for IT designers regarding the preferences of SME users.

Future research should focus on longitudinal studies examining the impact of digital platforms on SME performance, including growth metrics and customer acquisition. Another critical area is the exploration of how these platforms scale with business growth, addressing challenges like integration and cost implications. A comparative analysis across different regions and industries can provide insights into platform adoption trends and external influences. Additionally, investigating the integration of AI and emerging technologies in SMEs and their effect on operations is essential. Lastly, examining customer behavior and engagement strategies in digital marketing and e-commerce platforms could reveal the key factors influencing SMEs’ success.

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