Identification of Factors Influencing the Design Processes in Startups

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Abstract

The article indicates the processes of design construction for startup companies, particularly those that involve intelligent information technologies. The purpose of this study is to reveal how these processes affect the design development, team formation, and the construction of the design process itself in the company and which influencing factors of the process are the most effective, taking into account the interaction of factors. The results of this study can be used to develop strategies for constructing the design processes and best practices for startups in the information technology (IT) field in order to increase their chances of success in the market. Additionally, this study aims to identify the factors that require further investigation to gain a deeper understanding of the relationship between design processes and the success of IT startups.

Keywords 1

design process, start-up, influencing factors, graph, hierarchical model, user experience (UX), user interface (UI), analytic hierarchy process, information technology (IT)

1. Introduction

As it is known, startups are companies that work on solving a common problem where the outcome is often unclear, and success is not always guaranteed. Although most startups address similar issues, they use different business models. Startup is a new, modern, and innovative form of work [[1], [2]]. There are various definitions of startups and their purpose in literature sources. Startups are viewed as a more engaging type of company, with greater potential to influence company development and generate significant profits. However, achieving success often involves a series of trial-and-error experiments, which may lead to the company's birth or demise. The decision-making process is time-consuming and often carries high risks, particularly in the context of intelligent information technologies.

Startups encounter numerous challenges. Among others, it is possible to highlight the difficulty of obtaining an appropriate income and creating a client base. These are effortful challenges for beginners, as the existing information market is, in some cases, filled with competitors. Therefore, It is essential to offer a unique and compelling proposition that can capture the interest of potential customers.

Finding and securing financing is quite a significant challenge for beginners. The vast majority of this funding is external, so it might be problematic to find and interest investors. Sometimes such

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investors are established corporations often seeking startups for their potential to drive innovation and renewal [[3], [4], [5]].

In addition to the aforementioned challenges, startups may encounter several other obstacles, such as building an effective team of individuals who share a common vision, as well as navigating legal issues and managing financial resources. This primarily applies to new markets of intelligent information technologies, where there are no established regulations or clear guidelines to follow.

As studies show, innovation and management flexibility are crucial to the success of startups. Nevertheless, the considered literature sources have largely overlooked the importance of employing the design process in startups, which can enable a new product or service to reach its full potential and ultimately contribute to the success of an IT company.

In practice, design plays a critical role in the success of startups. In the early stages of a business, design can help establish a brand and create a unique identity that sets an IT company apart from its competitors. Effective design can also communicate the value and benefits of an information product or service to potential customers and enhance the overall user experience.

Design is a powerful tool for startups, particularly in the modern world of intelligent information technologies. One of its key benefits is the ability to establish a strong brand identity. Through effective design, IT startups can create a lasting impression on customers and build trust and credibility around their intelligent information technology offerings. This is especially crucial for startups that are competing with established brands in their market.

Also, it is worth noting that user interface (UI) and user experience (UX) design are essential components of any successful startup in the IT field. These elements pertain to the visual appearance of a product or service, as well as the overall experience of using it. By prioritizing UI and UX design, startups can create products and services that are not only functional and effective but also enjoyable and useful in the realm of intelligent information technologies [[6], [7]].

The research methods presented in the article, which include the use method of graphs and the analytic hierarchy process, have allowed for the identification of key factors that influence design processes in IT startups and systems, and have helped to establish their importance in the hierarchy of relationships between them. This approach has not been previously applied in this context and has thus provided valuable insights into the design processes of IT startups.

2. Literature review and problem statement

As the literature research has shown, there is quite a small amount of literature sources that focus specifically on the role and importance of design in IT startups, in contrast to the broader literature on startups in general. Here are some notable sources that provide valuable insights into this topic.

In the context of startups, conducting user experience (UX) research is of paramount importance as it helps to ensure that the products and services are designed keeping in mind the needs of the users. By gathering data on how users interact with products and services, startups can specify areas that require improvement and make informed design decisions that enhance the overall user experience. Since the interface serves as the point of interaction between the user and the product or service, a well-designed interface can have a significant impact on the overall user experience. Therefore, it is crucial to pay particular attention to interface design, as a poorly designed interface can cause frustration and confusion among users, leading to negative experiences and potentially driving them away from an IT product or service. This is especially relevant for information technologies used in medicine [[8], [9], [10]].

As the practice of the emergence and functioning of information technology shows, design plays a decisive role in the success of a startup. From creating a strong brand identity to enhancing the user experience and communicating the value of a product or service, design can be a key factor in driving sales and user growth. That's why it's important for startups to prioritize design and invest in high-quality design resources to build a strong foundation for their business.

One of the main benefits of investing in high-quality UI and UX design is that it can help improve the overall user experience of a product or service. This is especially important for startups, as a positive user experience can be a key driver of customer loyalty. Good UI and UX design can make a

product or service more intuitive and easier to use, leading to higher customer satisfaction and reducing the risk of user frustration.

An important component of the successful functioning of any information technology is the selection of competent employees and organizational units that ensure the quality of work in general [[11], [12]].

Conducting UI/UX research can help designers better understand user needs and preferences, and identify the areas for improvement in the interface design and flexibility of the system in general [[13], [14]].

It can be noted that works [[15], [16]] indicate that companies face constant changes in the international competitive environment in business. These changes have led to the continuous search for improvements. Therefore, in order to be more competitive and have the opportunity to develop and improve their technological process, it is suggested to use Agile UX products and services that would help in conducting business and obtaining good productivity. Using Agile UX technology enables digital startups to identify weaknesses in their operations and provides new strategic business ideas.

Other works [[17], [18], [19]] state that startups work in uncertain market conditions, namely with limited resources and time. Prioritizing UX design can offer startups a competitive edge, as it positively influences the success of a product or service in the market. The work investigates the impact of UX on flexible technologies and other factors that contribute to a positive outcome for a business. It is revealed that the lack of resources is a significant obstacle in the process.

In the analysis of publications carried out by the authors [[20], [21], [22]], concerning the use and implementation of UX practices in startups, it was indicated the impact UX has on the development of companies and the creation of a competitive product or service. As stated in the study, the use of UX increases the value of the software, namely, UX can be implemented through the method of gathering information about customers. Despite the proven benefits of implementing UX, some entrepreneurs neglect this issue due to perceived financial and human resource constraints.

In [23], a long-term study of UX actions identified six categories: research planning, data collection with users, data analysis, research design, organization and communication, and research training. This research data is essential for ensuring business sustainability.

Meanwhile, [24] presents an interesting study on the use of design in human life. The authors emphasize the need for designers to develop tools that can aid in creating sustainable products, systems, or services. The proposed concept is a bio-centered design that incorporates environmental sustainability as a third pillar, in addition to the already established economic and social pillars. The authors suggest that this approach should serve as a fundamental basis for the development of environmentally friendly products, systems, and services that support the future of the planet.

As can be seen from the literature sources, there are no works where the issue of software launch and work on UI/UX are investigated together. Based on this, the goal of this study is to discover the relationship between software development practices and UI/UX work in startups.

3. Determining the importance of factors influencing the design processes in startups

One of the areas of our research on startups focuses on the factors that contribute to their success. This study has identified a number of key factors that can influence the success of startups, including the quality of the team, the quality of the business model, the market opportunities, and the support level from the research institutions and other organizations. Another area of research examines the role of research institutions in supporting startups, including ways in which these institutions can provide funding, mentorship, and other resources to help startups succeed.

The next area of startup research focuses on the economic impact of these startups. This study has found that startups can play a significant role in driving innovation and economic growth, especially in industries such as biotechnology, information technology, and clean energy. Startups can also create working places and stimulate economic activity in the regions where they are located.

Overall, the research and studies of startups have helped shed some light on the unique challenges and opportunities IT organizations face and provided valuable insights into how they can contribute to

innovation and economic growth. A special role in the use of design processes in startups is also noted. As the market analysis shows, it sometimes plays a decisive role in the success of a startup.

The study of design processes in startups refers to complex processes in IT that cannot be characterized by certain values that could be used in calculations. It is known from the literature review that such calculations can be operated by a number of methods, including the method of analytic hierarchy process and the ranking method, which have proven themselves well in practice.

In this study, the method of analytic hierarchy process will be applied, since it uses dimensionless values-factors, thereby neglecting to bring the studied values to the same dimensions. This method was proposed by the American mathematician T. Saaty, which is based on a pairwise comparison of factors that are selected with the help of respondents and recognized as important when considering this process. In this method, a pairwise comparison scale is used, which has proven to be appropriate in practice and presented good research results.

3.1. Selection of factors influencing the design processes in startups

From the conducted survey among respondents, the following factors are highlighted regarding the identification that affects the design process in startups:

- customer value – understanding the needs and preferences of the customer is crucial for the success of the project. The design process of information technologies may involve gathering information through market research, user interviews, and focus groups to determine the functional requirements for the IT product or service, as well as the aesthetic and emotional factors that will appeal to the target audience. This information can then be used to inform the design of the IT product or service, ensuring that it meets the needs and expectations of the customer;
- business results – the design process must also consider the business objectives of the IT project. This may include factors such as cost, time to market, and revenue potential. For example, a project with a limited budget may require a more cost-effective design, while a project with short deadlines may require a more streamlined and efficient design process of a specific information system or technology;
- innovative culture – the culture of innovation in the organization can have a significant impact on the design process of an information system or technology. A culture that values and supports innovations can foster a more open and exploratory design process that allows for a wide range of ideas and approaches to be considered. Conversely, a culture that is more risk-averse or focused on maintaining the status quo may lead to a more conservative and gradual design process;
- organizational structure – the structure of the IT organization can also influence the design process. For example, a decentralized structure with a flat hierarchy can enable better collaboration and input from different teams, leading to a more inclusive and democratic design process. Conversely, a hierarchical structure with a centralized decision-making process can lead to a more top-down design process;
- team competency – the skills and experience of the team working on the project can also play some role in the development process. A team with different areas of expertise can bring a wide range of perspectives and approaches to the development process, leading to more creative and innovative solutions. Conversely, a team with limited experience can lead to a narrower and more traditional design process of an information system or technology;
- attitude to changes – the design process must also take into account the readiness and ability of the team to accept and implement changes. A team that is open to new ideas and willing to iterate on their projects can be more successful in finding the best solution. In contrast, a team that resists changes may have difficulty adapting and evolving their projects in response to feedback or changing requirements;
- level of project uncertainty – the design process can be more open and exploratory for projects with a high level of uncertainty, such as those related to new IT technologies or markets. In these cases, the design process of an information system or technology may involve a lot of prototyping and testing to determine the best approach. In contrast, projects with well-defined

requirements may have a more structured and linear design process, with clear milestones and deliverables;

- available resources – the design process must also consider the resources available to the team, including budget, time, and technological capabilities. These constraints can affect the scope and direction of the design process. For example, a project with a limited budget may require a more cost-effective design, while a project with limited development time may require a more efficient design process. Technological limitations, such as the availability of certain tools or software, can also affect the design process.

From the conducted survey, the most important factors are obtained, and they are assigned certain designations for their clarity and better operation during calculations, namely:

b_1 - Customer value (CV);
b_2 - Business results (BR);
b_3 - Innovative culture (IC);
b_4 - Organizational structure (OS);
b_5 - Team competency (TC);
b_6 - Attitude to changes (AC);
b_7 - Level of project uncertainty (LPU);
b_8 - Available resources (AR).

After identifying important factors influencing the selected process and using the method of hierarchies, it is necessary to construct a graph of relationships between these factors (Figure 1):

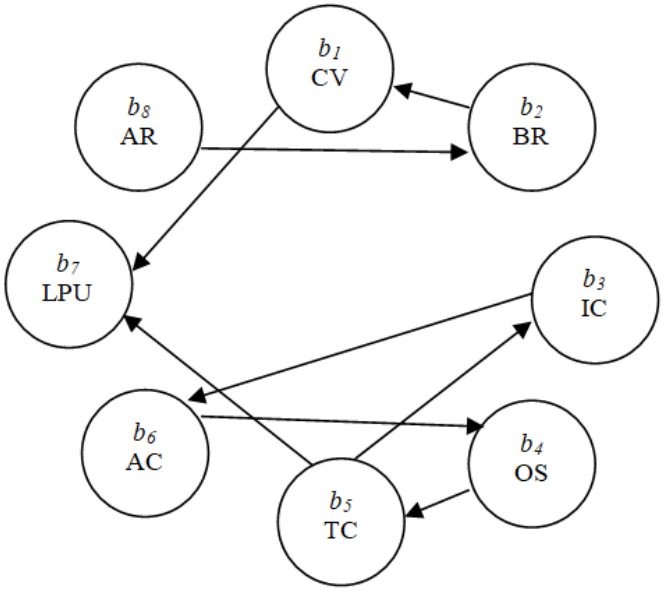

Figure 1: The initial graph of the relationship among the factors of design processes in startups

3.2. Determining the priority of factors influencing the design processes in startups

Using the method of hierarchies and taking the graph of relationships between factors as a basis, a binary dependency matrix B is constructed using the dependency [25]:

$$b_{ij} = \begin{cases} 0, \text{if factor } i \text{ does not depend on factor } j \\ 1, \text{if factor } i \text{ depends on factor } j \end{cases}. \quad (1)$$

For a better understanding of the matrix B, it is presented in Table 1, adding an information row and a column with the mnemonic names of the factors to it:

Table 1
The binary matrix of dependency

№		1	2	3	4	5	6	7	8
		CV	BR	IC	OS	TC	AC	LPU	AR
1	CV	0	0	0	0	0	0	1	0
2	BR	1	0	0	0	0	0	0	0
3	IC	0	0	0	0	0	1	0	0
4	OS	0	0	0	0	1	0	0	0
5	TC	0	0	1	0	0	0	1	0
6	AC	0	0	1	1	0	0	0	0
7	LPU	0	0	0	0	0	0	0	0
8	AR	0	1	0	0	0	0	0	0

On the basis of the binary matrix B, the reachability matrix is formed according to the following rule $(I + B)$, (where I is the unit matrix), which is raised to the power n so that the condition is performed [26]:

$$(I + B)^{n-1} \leq (I + B)^n = (I + B)^{n+1} \quad (2)$$

To fill in the reachability matrix with binary elements, according to this method, the following rule is used and it is presented in the form of Table 2:

$$b_{ij} = \begin{cases} 1, \text{if vertex } \ i \ leads \ to \ j \\ 0, \text{in another case} \end{cases} . \quad (3)$$

Table 2
The accessibility matrix

№		1	2	3	4	5	6	7	8
		CV	BR	IC	OS	TC	AC	LPU	AR
1	CV	1	0	0	0	0	0	1	0
2	BR	1	1	0	0	0	0	0	0
3	IC	0	0	1	0	0	1	0	0
4	OS	0	0	0	1	1	0	0	0
5	TC	0	0	1	0	1	0	1	0
6	AC	0	0	0	1	0	1	0	0
7	LPU	0	0	0	0	0	0	1	0
8	AR	0	1	0	0	0	0	0	1

The vertex is reached from vertex I if there is a path in the graph (Figure 1) that leads from vertex i to vertex j. Such a vertex is called reached. Let one denote a subset of such vertices as $R(b_i)$.

Similarly, vertex i is a predecessor of vertex j if it is reachable from this vertex. This subset of predecessor vertices is denoted by $B(b_i)$. The intersection of these subsets will be the subset [27]:

$$B(b_i) = R(b_i) \cap B(b_i) \quad (4)$$

The set of those vertices $B(b_i)=R(b_i) \cap B(b_i)$, for which the condition of unreachability from any of the remaining vertices of the set H is performed can be defined as a certain level of the hierarchy of the criteria priority actions.

Table 3, is formed. Subset $B(b_i)$ contains the elements of the i-th column of the reachability matrix, which have one [28]. The subset $R(b_i) \cap B(b_i)$ is formed as a logical intersection of the elements of the subsets $R(b_i)$ and $B(b_i)$.

Table 3
Levels of priority factors of the first iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$	
CV	1,7	1,2	1	
BR	1,2	2,8	2	
IC	3,6	1,5	3	
OS	4,5	4,6	4	
TC	3,5,7	4,5	5	
AC	4,6	3,6	6	
LPU	7	1,5,7	7	
AR	2,8	8	8	←

In Table 3, the equality $B(b_i)=R(b_i) \cap B(b_i)$ is performed for element 8. It corresponds to the factor of *available resources*. This is the criterion of the lowest priority level influencing the selection of design processes in startups.

Table 4 is formed as follows: the row with the number 8 is removed from Table 3, and the number 8 is excluded from the second column. Table 4 will look like this:

Table 4
Levels of priority factors of the second iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$	
CV	1,7	1,2	1	
BR	1,2	2	2	←
IC	3,6	1,5	3	
OS	4,5	4,6	4	
TC	3,5,7	4,5	5	
AC	4,6	3,6	6	
LPU	7	1,5,7	7	

Table 5 the third level of iteration, is formed as follows: the row with number 2 is removed from Table 4, and number 2 is excluded from the second column. Table 5 will look like this:

Table 5
Levels of priority factors of the third iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$	
CV	1,7	1	1	←
IC	3,6	1,5	3	
OS	4,5	4,6	4	
TC	3,5,7	4,5	5	
AC	4,6	3,6	6	
LPU	7	1,5,7	7	

Table 6 is formed as follows: the row with number 1 is removed from Table5, and number 1 is excluded from the second column. Table 6 will look like this:

Table 6
Levels of priority factors of the fourth iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$
IC	3,6	5	3 ←
OS	4,5	4,6	4
TC	3,5,7	4,5	5
AC	4,6	3,6	6
LPU	7	5,7	7

Table 7, the fifth level of iteration, is formed as follows: the row with number 3 is removed from Table 6, and number 5 is excluded from the second column. Table 7 will look like this:

Table 7
Levels of priority factors of the fifth iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$
OS	4,5	4,6	4
TC	3,5,7	4	5 ←
AC	4,6	3,6	6
LPU	7	7	7 ←

Table 8, is formed as follows: the rows with number 5 and 7 are removed from Table 7, and numbers 4 and 7 are excluded from the second column. Table 8 will look like this:

Table 8
Levels of priority factors of the sixth iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$
OS	4,5	6	4 ←
AC	4,6	3,6	6

Table 9, is formed as follows: the row with number 4 is removed from Table 8, and number 6 is excluded from the second column. Table 9 will look like this:

Table 9
Levels of priority factors of the seventh iteration

k_i	$R(b_i)$	$B(b_i)$	$R(b_i) \cap B(b_i)$
AC	4,6	3	6 ←

This is the last and most important priority level of factors of the seventh iteration of design processes in startups.

4. Results — construction of a multi-level structured model of priority of factors

With the help of the obtained results of the calculations of the iteration levels, a multi-level structured model of the priority of factors that affect the selecting process of design processes in startups is constructed (Figure 2) [[27], [28]].

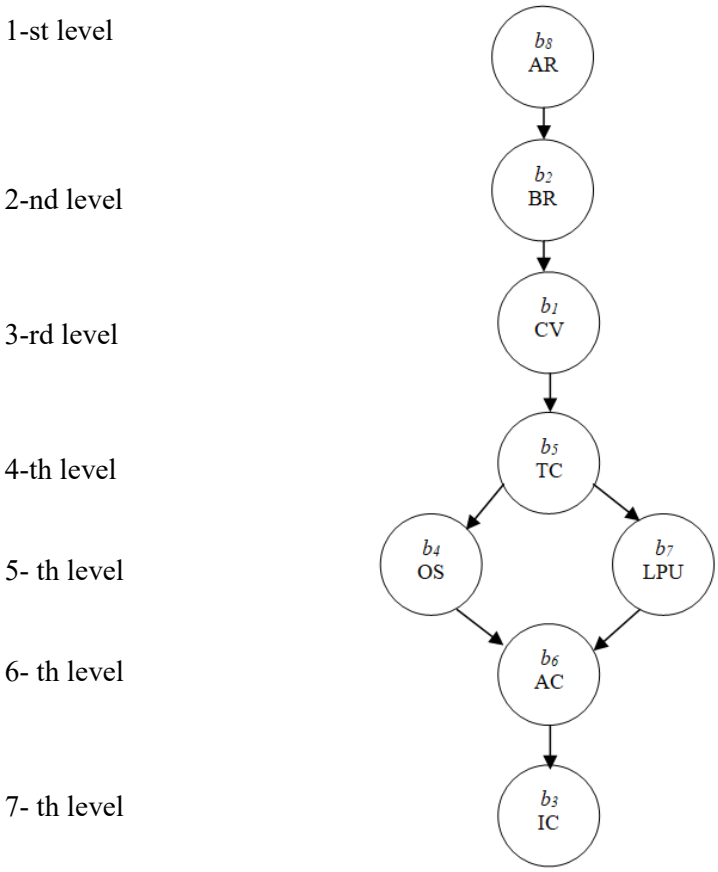

Figure 2: The hierarchical model of the priorities of factors influencing the design processes in startups

5. Conclusions

This way of presenting the hierarchy of factors influencing the UI/UX design, particularly in the selection of design processes in IT startups, illustrates how the priority of lower-level factors affects the priority of upper-level factors. According to this model, the most critical factor in selecting design processes in startups is b_3 — innovative culture (IC), and attention should be paid to this factor when implementing design processes in information technologies and systems. Additionally, the factor at the 6th level, b_6 — Attitude to changes (AC), is also essential, indicating the importance of embracing innovation.

The calculations indicate that the following factors are of lesser importance: b_4 — Organizational structure (OS) and b_7 — Level of project uncertainty (LPU), which is equally important; b_5 — Team competency (TC); b_2 — Business results (BR); b_1 — Customer value (CV). Based on the results, the least critical factor in the process of selecting design processes in startups is the 1st level of the hierarchy, b_8 — Available resources (AR). Therefore, by ensuring the quality assurance of higher-level factors, it is possible to ensure sufficient quality in the selection of the design processes in IT startups.

This modeling approach provides designers with a means of determining priorities during the development of UI/UX design processes in IT startups. By utilizing this method, teams can avoid outdated trial-and-error methods that waste time and effort in a fast-moving and highly competitive digital world. A well-established process allows teams to focus on important tasks and eliminates any uncertainties about the next steps.

This study enables teams to reduce errors resulting from misunderstandings. In a large project that involves collaborative work among many team members, such as information systems design and development, a well-defined protocol of actions helps everyone work together smoothly and follow its prescriptions without confusion.

In the future, the results of this study can be verified and reconciled with the results obtained using the pairwise comparison method, which generally provides more precise results when considering the importance of factors in the design processes of IT startups.

The proposed article can become a certain inspiration for researchers of information technology and systems implementation processes. It serves as a valuable source of knowledge for practitioners seeking to use modern methods to solve complex problems in information technology that cannot be described through mathematical quantities.

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