

# Applicability Of Gamification In Industrial Work Processes To Influence Target Variables

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## Abstract

Employees are still a key competitive element for many companies, especially small and medium-sized enterprises. Wherever automation in production is not feasible or not desired, employees carry out the necessary activities. Most of the time, these activities are linked to requirements or goals the employees have to meet or achieve. However, the activities are often monotonous and characterised by a high number of repetitions. For the performer's psyche, this results in reduced activity. The consequences can not only include fatigue, but also a permanent reduction in performance and job satisfaction. To prevent this, companies must regularly create new incentives that are adapted to the respective activities. The introduction of playful aspects into a normally non-playful environment, also called gamification, is an approach that serves to increase the motivation of employees and to purposefully guide their behaviour. The gamification approach has been used increasingly in different areas for some time. In industrial work processes, the approach has so far only been used for individual, specific issues. The aim of this paper is to present the basic suitability of gamification for use in industrial work processes based on evidence from the existing literature. To this end, the basics of motivational psychology and gamification are first presented. Building on this, a link to various target variables of industrial work processes is established. It is indicated that there are specific relationships between different designs of gamified applications and certain target variables of industrial work processes. In addition, the requirements for the design of such applications are taken into account.

## Keywords

Gamification; motivation; game design elements; mechanics; dynamics; target variables; industrial work processes;

## 1. Introduction

People today are confronted with games of various kinds in almost all areas of life, sometimes without consciously realising it. The instinct to play is deeply rooted in humans, it helps them to master developmental and relational issues and to overcome specific challenges. As long as the nature of the game is adapted to the developmental state of the person, age only plays a subordinate role [1]. Nowadays, this circumstance is used to motivate people to behave in certain ways through so-called *gamification* or to increase their contentment by satisfying their needs [2]. Gamification has been used for a long time in the areas of marketing, education and health care or in connection with business processes [3]. In marketing, gamification is often utilised for customer loyalty. For example within the framework of points systems such as Payback Points or on the basis of collected miles and associated rewards in frequent flyer programmes of

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airlines worldwide. *Nike+*, a system developed by Nike Inc., also uses the principle of gamification and, although it was developed with marketing as its motivation, shows how gamification can also be used in the health sector. Users of *Nike+* compete with each other by having the data on their physical activity collected by the app and put into the context of other users. This creates a competition that has a motivating effect on the users. It can also foster a feeling of social inclusion among the users [4]. This effect of gamification is also used in the treatment of diseases. Therapy apps such as "*I manage cancer*" developed by *Serious Games GmbH* help children to cope with their illness through targeted networking with other affected people [5]. Gamification has also been sporadically used in industrial work processes for several years, as it has been shown that motivational factors play a major role in determining the performance of employees [6]. Performance can be differentiated at the behavioural level addressed by gamification into the productivity and quality of performance [7]. In addition to productivity, the quality of execution, for example of a process, is also a possible target variable. Sailer was able to show the influence that gamification can have on these targets [7]. In addition to performance, there are other targets that are of interest in the connection with employees [8–11]. Increasing job satisfaction can also create a decisive competitive advantage for companies [12,13]. It significantly contributes to reduce absenteeism and fluctuation [12]. As previously mentioned, monotony can have a negative effect on the psyche and thus permanently reduce performance [14,15]. The effect of gamification depends on the design of the application, its designated users and the context in which it is applied [7,16]. Klevers examined a number of scientific studies on the use of gamification to increase motivation and performance as well as behaviour change and concluded that more than 46% of the studies showed exclusively positive results. Only 3% of the studies could also confirm negative effects. However, he also notes that the development and implementation of gamification requires a considered approach to ensure that the motivational and performance-enhancing potential of the application can unfold [7].

In this paper, the basics of employee motivation are first briefly presented. For this purpose, the terms extrinsic and intrinsic motivation are differentiated from each other and shortly explained in terms of their origin and impact. Through a classification in theories of psychological need satisfaction, a connection to components of gamification is then established. The components of gamification are explained in detail for a better understanding of the concept and its effects. Subsequently, the requirements for the utilisation of gamification in industrial work processes are outlined. Finally, it is shown in which function and with which goal gamification can be used in industrial work processes.

## **2. Extrinsic and intrinsic motivation in incentive design**

According to Reeves and Read, playful elements are indispensable motivating factors in companies in order to maintain committed employees and thus high productivity [17]. Motivation can be broken down into extrinsic and intrinsic motivation. Extrinsic motivation is triggered by external factors such as pressure, external incentives including money or other tangible rewards [18]. Intrinsic motivation, on the other hand, is derived from an inherent interest in an activity because the performer enjoys it or possesses a personal interest in the activity that goes beyond external rewards. It thus generates greater satisfaction than extrinsic motivation and its effect can be described as more long-term [19,20]. However, intrinsic motivation can also arise from an internalisation of extrinsic motivators [21]. Companies can therefore also indirectly influence the intrinsic motivation and job satisfaction of their employees through work design and thereby motivate them in the long run. Cerasoli et al. were able to show that intrinsic motivation is a moderate to strong indicator of performance, regardless of whether external incentives are present [18]. Nevertheless, the joint influence of incentives and intrinsic motivation is a success factor for the quantity and quality of performance. In a meta-analysis on the interaction of extrinsic and intrinsic motivators, Deci et al. described the negative effects of a preponderance of extrinsic motivators [22]. As a result of an imbalance, intrinsic motivation was overridden by extrinsic motivation. An effect also known as overjustification [23]. For a balanced incentive design, it is therefore necessary to understand how extrinsic and intrinsic factors interact

in the respective context and how intrinsic motivation can be achieved among employees. The different psychological perspectives that describe how intrinsic motivation is triggered in employees provide information on this and are explained below.

### **3. Psychological perspectives**

In the context of intrinsic and extrinsic motivation and the implementation within gamification approaches, there are a number of psychological perspectives and theories that can be applied to explain the motivational effects. In the following, three of these theories, the *Self-Determination-Theory*, the *Cognitive-Perspective* and the *Flow-Theory*, are presented and their implications for the design of gamification are elaborated.

#### **3.1 Self-Determination-Theory**

According to the Self-Determination-Theory (SDT), there are three universal psychological needs that determine whether intrinsic motivation is generated: competence, autonomy and social relatedness [24]. Also extrinsic motivation can be achieved through the satisfaction of the described needs [25]. If an activity cannot fulfil the needs through its inherent processes, there is the possibility of enriching it with playful elements [26]. According to Sailer, the following statements can be derived for gamified applications according to the self-determination theory with regard to motivation [27]:

1. Users are motivated by the experience of competence
2. Users are motivated by the experience of autonomy
3. Users are motivated by the feeling of social relatedness

#### **3.2 Cognitive Perspective**

Following the Cognitive Perspective, motivation is the result of Means-Ends analyses represented by models that combine expectancy with subjective value [28,29]. Relevant here are situation-specific goals, the expected outcome of one's own actions and/or the situation as well as their subjective evaluation [28,29]. Internal processes such as expectations, assessments and evaluations are therefore critical factors. A distinction is made between performance orientation and mastery orientation. While performance orientation refers to interpersonal comparability (e.g. among colleagues), mastery orientation focuses on self-imposed standards, resulting in intrinsic motivation and learning [30]. Based on Sailer, the following statements can be derived for gamified applications for the cognitive perspective with regard to motivation [27]:

1. The motivation of the users is promoted by clear and achievable goals
2. Highlighting the consequences of achieving a goal has a motivating effect on the users
3. The importance of a certain behaviour in a specific situation increases motivation for the person concerned
4. The mastery orientation in relation to specific goals promotes the motivation of the users

#### **3.3 Flow-Theory**

The flow theory was introduced by Csikszentmihalyi in the context of research on employee engagement and performance [31]. Flow is a mental state of performing an activity in which the person performing the activity is fully in a sense of focus, involvement and enjoyment of the activity. In the flow state, the experience of the activity is so pleasurable that the person performs the activity for its own sake [31]. According to Csikszentmihalyi, there are nine dimensions that contribute to the state of flow. Four of them are of interest in the context of industrial work processes and are therefore listed below:

1. The activity has clear objectives
2. Immediate feedback is given

3. The difficulty of the activity corresponds with the person's abilities
4. The activity is autotelic, which means that the person performs the activity for its own sake

It is important to note that these four factors are sufficient but not mandatory. They all contribute to the feeling of flow, but they do not all have to be present, which is why the other five dimensions are not listed here.

This equally applies to all the derived implications for the design of gamified applications. They are to be seen as sufficient requirements for an effective design, but do not have to apply in their entirety to the application. Regarding the SDT, this means that an application that promotes the employees' experience of competence can be successful even though the experience of autonomy and social integration for the employee are not strengthened. With respect to the Cognitive Perspective, it would be sufficient to highlight the consequences of achieving a goal without addressing the other three implications to increase the users' motivation. The implications are therefore to be seen as guidelines for a successful design. It is a question of the target to be improved that determines what behaviour should be motivated in the employee.

#### 4. Gamification

Gamification describes a concept in which playful aspects are used in a non-game context to increase motivation through need satisfaction or to influence behaviour through incentivization [32]. Regarding the non-game context, gamification must first be differentiated from serious games, in which learning content from non-game contexts is conveyed within a game developed for this purpose. Figure 1 illustrates this connection and the difference to gamification.

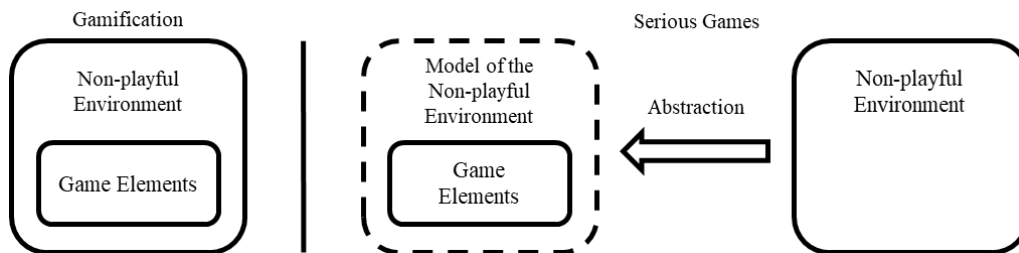


Figure 1: Differentiation between gamification and serious games based on [33]

Both serious games and gamification use game elements, but in serious games the actual execution of the activity from the non-game context is carried out only within the game [3,33]. One example is business games, in which the user plays in to learn, whereas in gamification the activity from the non-game context remains in the foreground and is merely enriched by game elements. The game elements that play an essential role in this context are discussed in detail in section 4.1. Unlike many other incentive systems, the concept of gamification does not necessarily rely on digital tools and extensive data collection systems. Nevertheless, these favour their use and open up a larger solution space for the design of such applications. The simple collection of points and the achievement of higher levels based on progress can also be realised in different contexts with the simplest of means.

To understand how gamification can be used specifically in a given context, the effect of the game elements must be explained and put into context with the goals pursued.

##### 4.1 Game elements

The components of gamification are defined differently throughout the literature [16,34,35]. Hunicke et al. describe the essential game elements for gamification in their MDA framework as *mechanics*, *dynamics* and *aesthetics* [36]. Werbach and Hunter define the game elements similarly and divide them into components, mechanics and dynamics, which have a causal relationship to each other. A detailed description of the

different elements is given in this section. The definition of Werbach and Hunter is particularly suitable for transfer to industrial work processes, since a direct link can be established between the game elements and the target variables typical for industrial work processes. The aesthetics described by Hunicke et al. are not considered in detail in this paper, as these are primarily described as design aspects of the gamified application in terms of visualisations which are not within the scope of the analysis. Figure 2 illustrates the connection and displays the direct and indirect sphere of influence of the designer of the gamified application as well as the degree of abstraction.

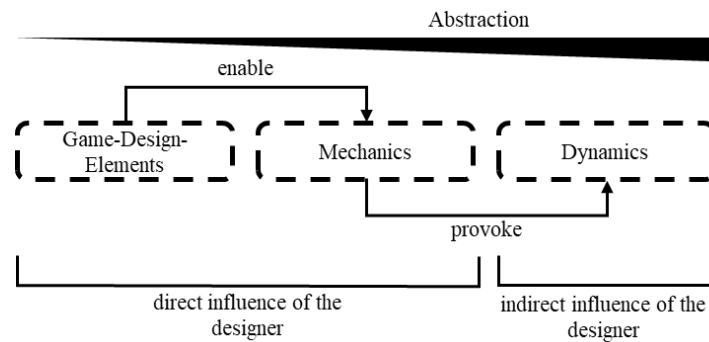


Figure 2: Interrelation of game elements, influenceability by the designer and degree of abstraction within gamified applications

Game mechanics of a gamified application consist of a set of components, hereafter called game design elements (GDEs). These elicit a corresponding reaction when used correctly. They allow the designer of the gamified application to guide the behaviour of the users through different combinations of GDEs and the use of certain mechanics. The mechanics in turn provoke dynamics that can ultimately affect the target variables (see 4.1.2). The degree of abstraction increases from the GDEs via the mechanics to the dynamics. For this reason, only the GDEs and the mechanics can be directly influenced by the designer of the gamified application. Dynamics are also dependent on acceptance and realisation by the users, which is why only an indirect influence can be assumed here. In the following, the game elements are presented in sequential order, each with a few examples, illustrating how the principle of gamified applications works.

#### 4.1.1 Game-Design-Elements

As the number of GDEs that can be used for the design of gamified applications is too large to be explained in full detail within this framework, the emphasis will be on a few central and frequently used GDEs in the following.

**Points** are the most widely used GDE because they are easy to apply and can be utilized in many different contexts. Almost all gamified applications require points, whether they are collected by a person or a group, or whether they are visible or invisible to the person or the group. For many other GDEs, such as levels, points are a basic necessity in order to be able to use them. They represent the metric to relate users of gamified applications to their own or external expectations or to compare them to other users. Points illustrate the interaction of users with the system and facilitate the information for necessary adjustments [35]. Zichermann und Cunningham distinguish five categories of points, each of which influences the users' experience of the game:

- Experience Points
- Redeemable Points
- Skill Points
- Karma Points
- Reputation Points

This distinction gives an idea of the variety of options in which points can be used as GDEs. It is also possible to classify them according to extrinsic and intrinsic motivators in the sense of the incentive design presented in section 2. While experience points, skill points, merit points and reputation points have no direct counter value and can therefore be classified as intrinsic motivators, redeemable points have an external incentive counterpart. Depending on the selection of the corresponding point system, particular incentives can be implemented.

**Level and leaderboards** are GDEs that build on the point systems described above. They generally serve to indicate progress on the basis of accumulated points and classify individual users of gamified applications in an overall context. Similar to points, the overall context can have different reference values such as time, activity or other users. Depending on the application, levels can define the difficulty or the central element of the application. Rankings, on the other hand, are a simple and easy-to-understand tool for drawing direct comparisons. They can be broken down into two categories [35]:

- No-disincentive leaderboards
- Infinite leaderboards

The main purpose of incentive-free rankings is to not demotivate the user by displaying a position in the ranking that is perceived as negative. Users are always shown in the middle of the ranking, with other users above and below them. In the case of an actual position at the bottom of the ranking, another reference value is used in which the user is not in the last position or is not shown at all to avoid negative incentives. Infinite rankings are designed on the premise that users will sooner or later be displaced from the ranking by other users. So they allow representation based on a modified reference such as colleagues or friends or simply a smaller group of people [35,37,38].

**Badges** serve as a visual representation of performance, which is achieved within the framework of the gamified application. They are awarded to users for pre-determined activities, which usually represent the completion of certain steps towards a goal [39]. Similar to rankings, badges are usually based on accumulated points and show a user's progress within the system [35]. However, to further motivate users, badges are not only utilized for achieving goals. They can also be time-related or awarded for the attempt to complete an activity without fully achieving the given goal [40].

**Avatars** play a major role, especially in the area of personalisation. They represent a virtual image of the user, which can be designed by the user according to his own ideas within the framework of the given possibilities. In contrast to actual virtual games, they are less common in gamification in non-game contexts, although by definition even a simple profile picture with a user name can be considered an avatar [35]. Especially the option to personalize and the associated possibility of free development (autonomy) of the users are seen as a valuable tool in the context of gamified applications [35].

**Narratives** are built around the non-game context in the sense of the gamified application. They are either completely fictional or refer directly or indirectly to the non-game context. Narratives are seen as a means of motivating users to pursue the activity with greater concentration and motivation, especially in contexts that are perceived as boring and unstimulating [41]. Narratives often embed other GDEs to enhance the experience for the user. For example, activities and characters can be structured within the narrative, which enhances the perceived meaning for the user [7]. However, this effect can only be achieved if either the narrative can be actively influenced by the user or the user feels that the path laid out in the narrative is worth following [42].

The GDEs described above are only a fraction of the GDEs available for the design of gamified applications. Especially in the area of playable applications for smartphones, a much larger amount of GDEs is used to guide the user's behaviour, but also in contexts such as industrial work processes, there are many possibilities to use a vast amount of GDEs. The almost infinite number of possible combinations, combined with the

other factors influencing the impact of gamified applications, results in a multidimensional decision problem for the selection of GDEs [43].

#### 4.1.2 Mechanics

Similar to the game elements, there are a number of different definitions of mechanics in the context of gamification in relevant literature [16,32,35,44]. In the frame of this paper they are defined as follows: Mechanics are the predefined rules that define how users interact with the GDEs in a given setting. The designer of the application has control over which mechanics he integrates into the gamified application (see Figure 2). This is also the point of differentiation from the dynamics, which the application designer can influence indirectly but not directly (see Figure 2). The interaction of the user with the gamified application creates the so-called dynamics. Nevertheless, the boundaries are often fluid and it is not always possible to draw a clear line. The easiest way to illustrate this is with an example: The awarding of points (GDE) for completed activities gives users feedback (mechanics) about the execution itself or the degree of goal achievement.

**Feedback** is an essential part of almost every gamified application. It is the response of the system as a consequence of an action performed by the user. The feedback can be transmitted visually, haptically or auditorily or in mixed forms. This enables employees to assess their own performance and make adjustments if necessary. Feedback is therefore closely linked to the feeling of self-efficacy, which means that the better the feedback, the higher the performance adjustment, as it then leads to more confidence in the user's own abilities [45,46]. Feedback can therefore also be seen as an essential driver of change processes. The effect of direct feedback has already been proven in the context of gamification in various studies [19,47,48]. Feedback is also one of the four relevant components of the Flow-Theory with regard to industrial work processes, as explained in section 3.3.

**Progress** can be represented by GDEs such as badges and the accumulation of points (e.g. experience points). Levels and leaderboards are also GDEs that are associated with this mechanic and can be considered as an option for visualisation. In order to encourage users to engage more through quick successes, progress is often shown to a greater extent at the beginning [40]. In connection with set goals, the visualisation of progress additionally helps to motivate users to continue pursuing the goal [49]. Motivation is particularly strong when users know that they are very close to the goal [50]. On the other hand, showing lack of progress can also have a demotivating effect [50]. Further theories assume that the rate of progress towards the goal can be more critical than the actual distance from the goal itself. Thus, the decisive factor for motivation is whether reduction of the discrepancy between the current status and the goal to be achieved is acceptable to the user [51].

**Challenges** are associated with the feeling of competence when successfully mastered and are therefore directly attributable to an increase in motivation following the SDT [52]. For the design of the challenge, the feasibility by the user plays a decisive role [53]. A challenge that is too difficult can have the opposite effect, reducing motivation and engagement, and in the worst case, leading to frustration [40]. One advantage of challenges that only arises in the context of the gamified application is that failure within the application does not have the same negative impact as failure in the real world. It is rather an opportunity to learn from mistakes and start again, as gamification breaks down the concept of failure into smaller parts [40].

#### 4.1.3 Dynamics

The effects that emerge from the mechanics generated by the combination of GDEs are called dynamics [16]. They represent the highest level of abstraction and are directly linked to the objective intended by the gamified application. Transferred to the example from 4.1.2, a dynamic would be a competition that arises because users try to collect more points than other users in to strengthen their reputation. This example also shows that dynamics and mechanics cannot always be clearly distinguished from each other. As shown in

Figure 2, the direct influence of the designer of the gamified application ends with the mechanics, but a competition may well have been the intention of the gamified application. Whether the intended behaviour actually occurs depends also on the users and not solely on the structure of the application. With regard to the users, for example, the acceptance of the application and their general attitude towards gamification play a major role.

**Competition** is created on the basis of data, which can be compared with each other. By using points as GDE in the context of gamified applications, users are given the opportunity to compare their number of points with each other. If additional mechanisms such as levels or rankings are used, this promotes the emergence of competition. However, whether competition actually arises or is perceived as such ultimately depends on the users and their attitude towards the gamified application. If users enter the competition, a higher performance can be achieved in part through the competitive elements than would be possible without the competition. In addition, the mere comparison of performance can create a sense of satisfaction [54].

**Altruism** describes a way of thinking and acting that is based on selflessness and consideration for others. For humans, giving is a strong driver of satisfaction when a community exists in which people want to maintain their relationships [54]. It is often also associated with a sense of heroism [35]. In gamified applications, giving or gifting is used as an acquisition and retention mechanism. This can strengthen relationships, which in turn motivates employees. A GDE that is often used in this mechanic are the karma points described in section 4.1.1. [35].

Figure 3 serves to illustrate the relationships described in section 4.1 and also shows the link to target variables of industrial work processes.

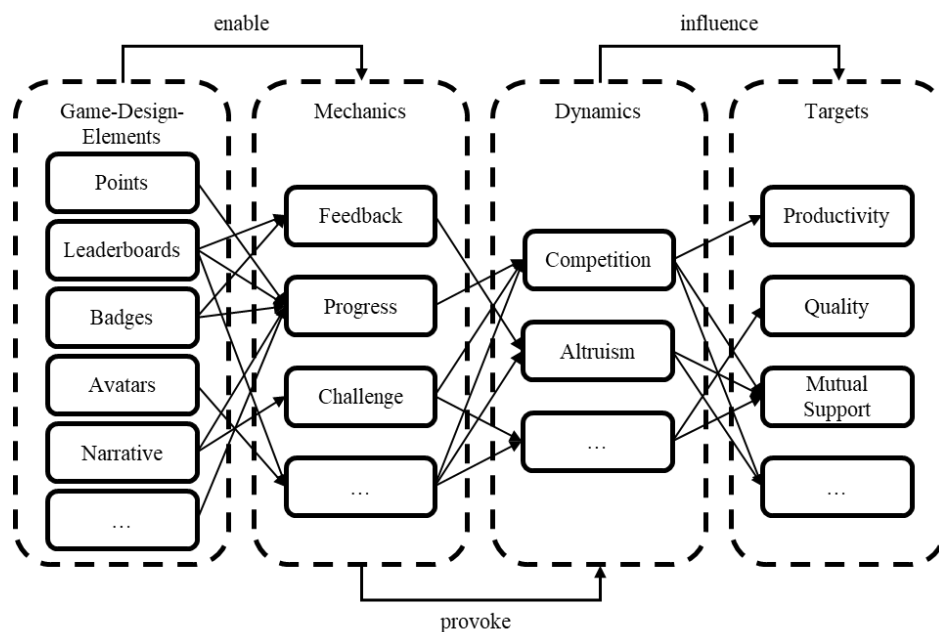


Figure 3: Interrelation of game elements and target variables of industrial work processes

## 5. Applicability of Gamification in industrial work processes

From the previous explanations it can be concluded that there are certain factors that favour the use of gamification in industrial work processes. However, there are also requirements that must be considered for a successful implementation of an incentive system [55]. Besides some general requirements, further requirements can be derived from the variables that influence the design and implementation. This results in the following classification of requirements, which is shown in Figure 4.



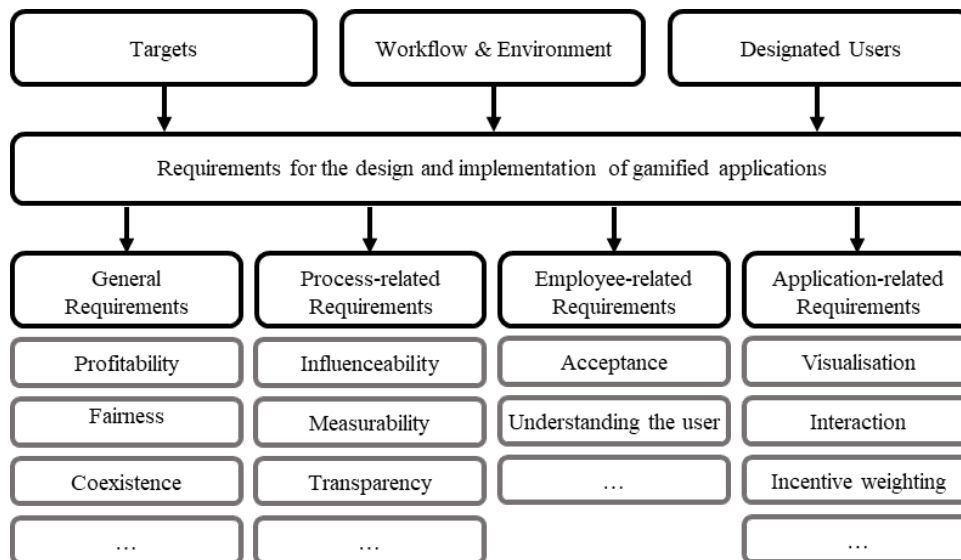


Figure 4: Requirements for the design and implementation of gamified applications

*General requirements* can be described as largely independent of the type of incentive system and the other influencing variables such as context and user. These include requirements for profitability, fairness and conflict-free coexistence with other incentive systems [56]. In addition, there are *process-related requirements* regarding the context in which gamification is to be used. If certain results of the process are to be incentivised, it must be possible for the employee to influence the result to a sufficient degree. This requirement is directly linked to the requirement for measurability of the results. In addition, the granting of incentives must be transparent to avoid the feeling of injustice [57]. The example in section 4.1.3 also illustrates how employees and their characteristics are an essential factor in this consideration. These *employee-related requirements* include their acceptance as the most important criterion [58]. To fulfil employee requirements, their individual motives must be understood and integrated into the design of the application. *Application-related requirements* relate directly to the design and integration of the gamified application. In industrial work processes, the focus on the activity is of great importance for reasons of occupational safety. On the other hand, visualisations (aesthetics - see section 4.1) are an important part of gamification. For use in industrial work processes, gamified applications must therefore be designed in such a way that both visualisation and interaction with the application do not pose a safety risk [3]. In addition, incentives must be weighted in a way to ensure that essential target variables are not worsened by their use. For example, productivity alone cannot be stimulated if quality standards can no longer be met as a consequence. Apart from the requirements, there are factors that favour the use of gamification. These should not be part of this elaboration, but future research on them is considered useful to support the implementation of gamification.

## 6. Influence of Gamification as an incentive system on target variables

Study data indicates that productivity and efficiency at work can be increased by up to 4% if overall satisfaction is improved by just one percentage point [59]. The ability of gamification to influence motivation and job satisfaction has already been outlined in sections 2 and 3. However, gamification is also suitable for the improvement of practical targets in industrial work processes by stimulating certain behaviours through game elements [8–11,33,58,60–62]. The goal that can be achieved (target variable that can be improved) with the implementation of the gamified application essentially depends on the design of the application, its effect on the users and the context [7,16]. Warmelink et al. point out that in the context of industrial work processes on the shopfloor, gamified applications work primarily with points, achievements, rewards, levels, goals, progress, metaphorical and fictional representations, as well as multimedial feedback to achieve

different goals [13]. This paper is intended to provide an overview of the exemplary target variables that can be addressed using gamification due to existing literature. Further research is needed to evaluate how individual process parameters affect the design of the gamified application and its impact on target variables. It should be noted that this is only an excerpt of the possibilities and does not claim to be complete. Figure 3 illustrates three of these target variables by example. Henke und Kaczmarek differentiate targets for the use of gamified applications into higher-level targets and behavioural-level targets [8]. The higher-level targets are understood as a competitive factor, as they primarily relate to the company, while the targets at the behavioural level focus on the development of the employees and the immediate impact of their actions. To further classify which functions gamification can exercise in industrial work processes, a definition by Becker on functions of incentive systems is used [63]. According to Becker, incentive systems can perform four different functions, which partly overlap: *motivation function*, *control function*, *information function* and *change function*.

The *motivation function* refers to the activation of employees' personal motives and can therefore also be referred to as the *activation function*. Cognitive components are specifically promoted in order to increase need satisfaction or the willingness to perform. The principles for increased motivation through motive activation were explained in sections 2 and 3. The increased willingness to perform also leads to an improvement in the employee's performance output, which can directly influence process-related target variables [64]. Thus, increased motivation represents the direct goal, while process-related goals are meta-goals of increased motivation. Accordingly, the motivation function refers primarily to the higher-level targets shown in Table 1. To serve this function, game elements of gamified applications must be selected in a way that supports need satisfaction and performance readiness.

If the incentive system fulfils a *control function*, elements of the incentive system are designed in such a way that the achievement of operational goals is promoted [63]. This is usually achieved by using rewards for the intended behaviour. The majority of the behavioural-level targets shown in Table 1 can, among others, be assigned to this function. The control function is relevant wherever employees can or must make decisions within the scope of their activities. Such degrees of freedom are very important for the experience of autonomy and thus for intrinsic motivation (see section 3.1). At the same time, some of the decisions may have an influence on the target variables. If an employee can influence the processing sequence, his or her decision to alter the sequence may lead to poorer adherence to delivery deadlines and consequently to reduced logistics performance. If employees are forced to make decisions that have an impact on the target variables, the information about the consequences of their decision plays a decisive role. Therefore, when gamified applications address the employees' degrees of freedom via reward structures, those rewards signal to the employee which decision has a positive impact on the target variables. Gamification offers the possibility to fulfil this function through the usability of points, badges and other reward structures.

Within the framework of the *information function*, elements of the incentive system inform the employee directly or indirectly, for example, about management policy, strategies, the desired organisational culture or preferred process execution and behaviour [63]. It enables the employee to draw conclusions about the behaviour expected of him and the associated rewards or sanctions [63]. This serves to communicate to the employee the existing goals and their importance in the organisation. The employee can use this information to align and prioritise his work according to these goals [65]. This shows the close connection with the control function. The information conveyed to the employee as incentives to guide his behaviour fulfils the information function. The information function can therefore be seen as a prerequisite for the control function with similar design requirements and possibilities for gamified applications.

When requirements change due to strategy changes, incentive systems can contribute to making employees aware of the new demands. The incentive system then fulfils a *change function*. By adapting incentives, the implementation of given change strategies can be promoted [63]. In the context of change processes, gamification could be used, for example, to increase employees' acceptance of innovations, such as new

technologies [10,11]. Vice versa, digital technologies in combination with gamification offer the opportunity to harness the creativity and energy of employees for the benefit of the company [66].

In the explanations, the intersections between the functions mentioned at the beginning become clear. It essentially depends on the objective which function the gamified application is to perform. It thus represents an important component of the influencing variables for the design of gamified applications by using different GDEs and mechanics. Table 1 shows different targets of previous approaches for gamified applications that are relevant for industrial work processes. According to the classification by Becker, the targets are divided into higher-level and behavioural-level targets and assigned to the different functions.

		Higher-level targets										Behavioural-level targets												
		Increased motivation	Creating joy of application use	Qualification for the job	Encouraging fun at work	Increasing willingness to perform	Improving employee learning process	Creating awareness of work done	Increasing acceptance	Encouraging action or interaction	Improving communication	Faster work	More accurate work	Compliance with company standards	Self-control and personal decision for adjustment	Mutual or team support	Improving personal work	Making suggestions for improvement	Pointing out problems	Discussions with colleagues	Ergonomic working	Regular usage	Storage and transfer of expert knowledge	
Gamification function	Motivational function	●	●		●	●	●	●	●	●	●	●	●			●	●						●	
	Control function											●	●	●	●	●		●	●		●			●
	Information function							●	●				●	●	●	●		●	●	●	●			●
	Change function			●			●		●								●	●						

Table 1: Possible functions of gamification in industrial work processes in connection with the addressed target variables based on [8–11,33,60–62,67]

Multiple assignments are the result of intersections between the functions. It is assumed that the function being performed also indicates which GDEs and mechanics are to be used in the design. The information, which function gamification should fulfil in the specific use case, can therefore support the selection of the appropriate game elements. The classification of the examples of previous approaches shows that gamification with its motivational elements is primarily used to increase motivation but can also perform a control-, information- or change function. Future research on design guidelines depending on the target pursued is necessary.

## **7. Summary and future work**

This paper focuses on the concept of gamification, its fundamentals, requirements and the relation to target variables of industrial work processes. First, extrinsic and intrinsic motivation were explained and differentiated from each other. The construct of motivation was then placed in the context of psychological perspectives in incentive design. Based on this, the concept of gamification and its components were presented in detail and existing cause-effect relationships were indicated. Relevant requirements for the implementation of gamification were discussed. Subsequently, the correlation to target variables was shown by describing which functions gamification can fulfil in industrial work processes.

Although there are a number of approaches to the use of gamification in industrial work processes in the literature, they tend to be of an experimental nature. There are also isolated approaches for the selection of the corresponding GDEs, which, however, do not or only partially take the requirements for the application in industrial work processes or the characteristics of the employees into account. Therefore, more approaches with theory-based design that consider all relevant variables are needed. In order to develop a holistic approach to the design of gamified applications, the special requirements of industrial work processes must be identified, the interdependencies must be analysed and both placed in the context of design options for gamified applications. These can then be integrated into a model for implementation that takes into account the relevant requirements and can be used by companies as a basis for implementation.

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