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Gamification of production and logistics operations: Status quo and future directions

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ABSTRACT

This article presents a review of the current body of academic literature concerning gamification of production and logistics to understand the status quo and provide suggestions for future research. The findings indicate that the execution and control of production and logistic processes has been addressed most often in the current body of literature, which mostly consists of design research. Objectives and goals, points, achievements, multimedial feedback, metaphorical or fictional representations, and levels and progress are currently the most often employed affordances within this field. Research has focused in the given context on examining or considering motivation, enjoyment and flow, as the main psychological outcomes of gamification, while individual performance and efficiency are the most commonly examined or suggested behavioral and organizational impacts. Future studies should employ more rigorous designs within new subdomains of production and logistics and should firmly ground research designs and discussions in management theory and critical studies.

1. Introduction

Recently, the design approach of gamification has started to gather the attention of academics and practitioners as a way to increase performance of production and logistic operations in real-life organizational contexts. Since games have become a part of a larger cultural and societal development and since gameful interaction permeates aspects of everyday life and work, the concept of gamification is often used to refer to the design approach that implements elements (affordances, mechanics, technologies) that are familiar from games in contexts where these elements are not commonly encountered (Deterding, Dixon, Khaled, & Nacke, 2011; Huotari & Hamari, 2017; Vesa, Hamari, Harviainen, & Warmelink, 2017). The goal of gamification is typically to induce experiences that are common in gaming and to create and increase motivation or engagement via these experiences. Two aspects are at the heart of gamification. First, all gamification applications are designed for their users' entertainment or enjoyment. Second, gamification applications are designed for particular external consequences, for example individual behavior and activities or organizational performance (Huotari & Hamari, 2017). In an organizational context,

gamification does not take employees out of their actual work environment and into an educational or training situation. This is unlike common applications of simulation and serious games. Instead, gamification intervenes directly in daily operations through game mechanics, with or without the aid of some game technology. An essential aspect of applying gamification is indeed its nature that seeks to enhance a particular core activity with the gameful experiences, without interfering with or impeding these core activities (Huotari & Hamari, 2017; Liu, Santhanam, & Webster, 2017).

The general understanding of gamification, and whether it achieves the intended results and how, is still evidently under development. More research is required for developing a solid theoretical as well as methodological base on which knowledge can be accumulated (see e.g. Hamari, Koivisto, & Sarsa, 2014; Seaborn & Fels, 2015). Although there is a growing amount of empirical literature on gamification and how it affects people's motivation and behavior, it still remains unclear as to what kind of gamification features may affect which specific motivation and behavior of which people (Hamari, Hassan, & Dias, 2018), and under what circumstances. The amount of gamification features, their combination as well as their position in a particular context, creates a

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situation with a near endless space of possibilities. Therefore, simply attempting to answer the general question whether gamification works is too simplistic (Hamari et al., 2014; Koivisto & Hamari, 2014; Seaborn & Fels, 2015; Landers, Auer, Collmus, & Armstrong, 2018). Furthermore, as the outcomes of gamification are highly dependent on contextual factors, research in specific domains and tasks is required. Thus far, the literature on gamification has been mostly focused on the domains of education, crowdsourcing and health (Hamari et al., 2014; Morschheuser, Hamari, Koivisto, & Maedche, 2017), while most other domains receive only limited attention.

As the general body of literature on gamification continues to grow, more varied domains and perspectives are being investigated. Organizational contexts, ranging from management to various forms of services and industrial processes, have been among the less studied domains for gamification till now. However, as the potential of gamification is being increasingly discussed in various organizational contexts (Cherry, 2012; Dale, 2014; Suh, Cheung, Ahuja, & Wagner, 2017; Vesa et al., 2017), more results are expected to be published in coming years.

The interest in gamification of the work floors of production and logistics has increased over the past five years, as demonstrated in this paper. This may be explained, for example, by the following reasons. Firstly, operational activities in production and logistics are often simple and monotonous, given their highly structured, standardized, and repetitive nature. Workers' enjoyment and work satisfaction and, consequently, organizational performance could improve if gamification delivers its promises. Secondly, sensor technologies have heavily permeated the production and logistics work floor over the past decade (Xu, He, & Li, 2014), making it easier to connect work data to common gamification technologies and principles, such as scoring systems and leaderboards. Thirdly, the cost-efficiency of automating very complex work in this domain is often still too low (Korn, Schmidt, & Hörz, 2012). Investing in the workers, the work processes, and conditions is thus seen as an attractive option, with gamification offering interesting possibilities.

Gamification, however, has sometimes been regarded as coercive, exploitative, and a way to detach workers from their intrinsic motivation (Bogost, 2015; Morschheuser et al., 2017). These views seem to stem from a very specific way of understanding gamification (Koivisto & Hamari, 2014), but they should also be acknowledged and investigated. It is therefore important to uncover how gamification is actually used, whether it is to support workers' intrinsic motivation or quite the opposite. Either way, the increasing interest in gamification requires the development of a body of knowledge on gamification design and impact for the rather particular domain of the work floor of production and logistics operations.

To contribute to this developing field and to promote future research on gamification in organizational contexts, this article reviews the already available research literature on gamification of the work floors of production and logistics. The objective is to understand the status quo of this field and to provide suggestions for future research. More specifically, this article reviews which aspects of production and logistics operations are addressed, what methodologies are employed, what motivational affordances are applied or considered, and what are the expected and measured psychological, behavioral or organizational outcomes and impacts.

2. Material and methods

The literature search was conducted in the Scopus database in 5/2017. Scopus indexes contents of all other databases with potentially relevant content, e.g. ACM, IEEE, Springer, and the DBLP Computer Science Bibliography. Using only one database instead of several was considered a preferable method in order to increase the rigor, clarity and replicability of the literature search process (Paré, Trudel, Jaana, & Kitsiou, 2015).

The following search string was used for the Scopus search: (TITLE-ABS-KEY(gamif*) AND TITLE-ABS-KEY(logistic*) OR TITLE-ABS-KEY(production)). Thus, the search returned entries with a mention of gamification or some form of the commonly used root verb 'gamify' and either the term 'logistic' or 'production'. The search string was limited to return only such hits when these terms existed in the metadata, that is, in the title, abstract or keywords. No other limitations, for example in terms of publication type (a journal article, a short or full conference paper, a workshop paper) or type of paper (theoretical or empirical study) were employed.

The literature search resulted in 103 hits, which were further inspected for inclusion or exclusion with the following criteria: 1) the entry was a research paper and not, for example, a proceeding summary or a conference review, an editorial, or a book introduction; 2) the paper was written in English; 3) the paper was related to logistics or production as discussed in this article; and 4) the paper was not focused on the use of games in or the gamification of formal education (i.e., at educational institutes) concerning production and logistics, or otherwise not focused on actual gamification on the primary process level of the production and logistics work floor. This means that common supportive and foundational aspects of production and logistics business were omitted, such as corporate strategy, finances, human resource management, marketing, sales or ICT support. Furthermore, one duplicate study was identified of which only the most recent paper included in the review.

After inspecting the search hits following the described criteria, 18 papers were initially identified as the body of literature to be reviewed. Next, a backward-forward search was conducted on the references of and citations to these 18 papers. This procedure, however, did not reveal any additional papers that met the above-described criteria for inclusion. Therefore, the final selection of papers for the body of literature consists of the 18 studies. The literature search procedure is reported in Fig. 1. A full list of the 18 studies is provided in Appendix A. In the text, the reviewed studies are referred to with the Appendix IDs: A1, A2, etc.

After the identification of the relevant body of literature, the papers were analyzed: firstly, author-centrally, and secondly, concept-centrally, following the guidelines of Webster and Watson (2002). In the

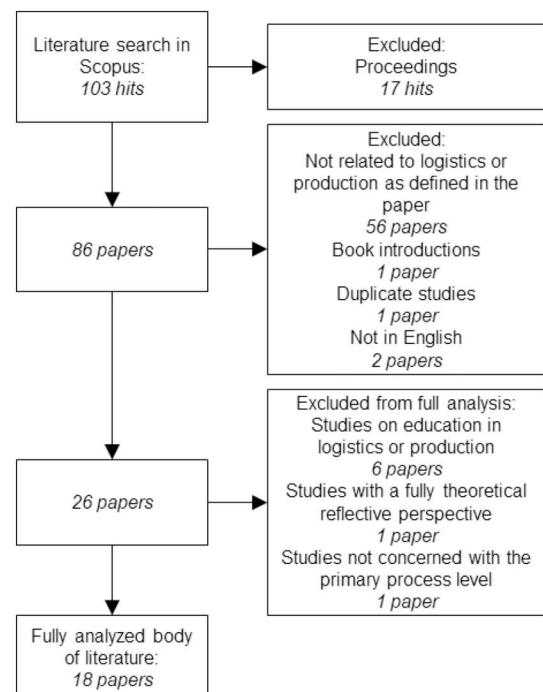


Fig. 1. Flowchart describing the literature search procedure.

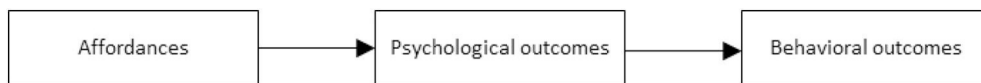


Fig. 2. Conceptualization of gamification (Huotari & Hamari, 2017).

author-centric coding phase, pre-defined units of analysis were examined and coded for each paper. This procedure led to a matrix of coded literature. In the concept-centric phase, the coded literature was then organized based on the specific units of analysis. During this step of the process, the coded concepts were comprised into frequency tables (see Webster & Watson, 2002), that represent the core of this review. Thus, the frequency tables present the units of analysis as well as the coding used in the analysis process.

The actual framework applied in this analysis follows the theoretical understanding of both the application domain (production and logistics work floor), as well as the gamification design and its application. In the next section these two aspects are elaborated with regards to the applied analysis.

3. Theory

3.1. Production and logistics of the work floor

Evidently, production and logistics together comprise a large field and pertain to a wide variety of processes (see e.g. Chase, Aquilano, & Jacobs, 1998; Christopher, 2016; Cooper, Lambert, & Pagh, 1997), all of which could be individually considered from the perspective of gamification. This study focuses on the primary process of production and logistics of the work floor, that is, the operational core of the work that often takes place on a factory floor or in a warehouse, truck, train, ship or airplane. This review is further demarcated by the assumption that the primary process of production and logistics consists the operational activities of designers, engineers, managers and laborers involved in the mass scale production of products and services that, in the end, are delivered to their designated place of consumption.

The various aspects of and processes within production and logistics are categorized according to the following subdomains, based on a common understanding of this particular domain (Vitasek, 2013):

- 1) Product and process engineering: the development and implementation of interconnected technologies, machines or processes for efficient mass production of a product or service to be delivered at one or more locations;
- 2) Production planning: the efficient organization of the entire production process, varying from the timely delivery of necessary technologies and materials through the supply chain to arranging the required personnel;
- 3) Production execution and control: completing tasks in the actual production process, ensuring that the entire production process is continued from start to finish and an intended quality level of the work is reached, and rectifying faults and managing unforeseen events or outcomes;
- 4) Supply chain design and planning: the design and efficient organization of the delivery of technologies, materials, products and services required for production processes to their appropriate locations;
- 5) Transportation planning and execution: moving and temporarily storing technologies, materials and products, often via intermediary steps or hubs, to their point of use and consumption.

3.2. Gamification

Gamification refers, broadly speaking, to a kind of design that attempts to transform systems, services, activities or organizations into a more game-like variety (Huotari & Hamari, 2017; Vesa et al., 2017). Gamification, therefore, commonly involves the use of game design as a

means to invoke similar experiences as games do and further affect the behavior of the people involved (within contexts not traditionally perceived as games or gameful) (Huotari & Hamari, 2017; Vesa et al., 2017). Therefore, gamification can be further broken down to three primary elements of interest (Huotari & Hamari, 2017): gamification design, intermediate psychological outcomes, and behavioral outcomes (see Fig. 2).

The gamification design outcome consists of *affordances* that build on game design and on interactions that are common in games. The concept of affordances refers to the designed properties of a system, either perceived or actual, that determine how a person may use the given system (Norman, 2013). The user of a system is not forced to act upon these system properties; instead, affordances rather “enable” certain actions, in case the user perceives them and chooses to act upon them. Therefore, in the context of gamification, affordances most often refer to a set of design elements characteristic for games.

Psychological outcomes refer to any psychological effects and experiences that the implementation of the gamification is seeking to evoke from the user. These are experiences and effects that are commonly induced by games, for example, senses of mastery and competence, relatedness and sense of community, creativity and playfulness, enjoyment and flow (see e.g. Ryan, Rigby, & Przybylski, 2006). In the gamification literature, these effects and experiences are connected to intrinsic motivations of the game user (see e.g. Deterding et al., 2011; Huotari & Hamari, 2017; McGonigal, 2011; Ryan & Deci, 2000). Finally, *behavioral outcomes* refer to any activities or behaviors that the gamification seeks to support.

Gamification is usually situated within a certain context and attempts to elicit a type of behavior related to that particular context (see e.g. Deterding, 2015; Hamari et al., 2014; Huotari & Hamari, 2017). Therefore, the domain in which gamification is situated, the social and cultural context within which the activity takes place, and the demographic and individual characteristics of the users are important aspects to consider in the gamification design and research. Prior research on gamification has indicated that, for example, demographic factors influence how the gamification is perceived (Koivisto & Hamari, 2014). Furthermore, the domain of activity and the way these activities are perceived may affect the users' willingness to engage with the gameful features (Hamari, 2013). Consequently, the effectiveness of a gamification system established in one domain does not necessarily translate easily into another domain.

This study, in particular, attempts to make clear how gamification is represented within the aforementioned subdomains of production and logistics on the work floor by investigating the affordances, psychological outcomes and behavioral outcomes in the related literature. Moreover, this literature review is extended to also include organizational impacts (e.g., increases in turnover or profit). The underlying assumption for this extension is that organizational impacts were often deliberately targeted by the involved organizations or at least connected to the behavioral impacts that were evoked. Together, these four concepts form the analytical framework for this literature review.

4. Results

Fig. 3 summarizes the main results of the literature review that is based on the analytical framework described above. It shows that the gamification studies reviewed were mostly concerned with the category of production execution and control (15 out of 18 studies; see Table 1). Furthermore, most of the studies examined gamification of this sub domain in the context of private or semi-public (sheltered work) organizations. For example, several publications offered results of a

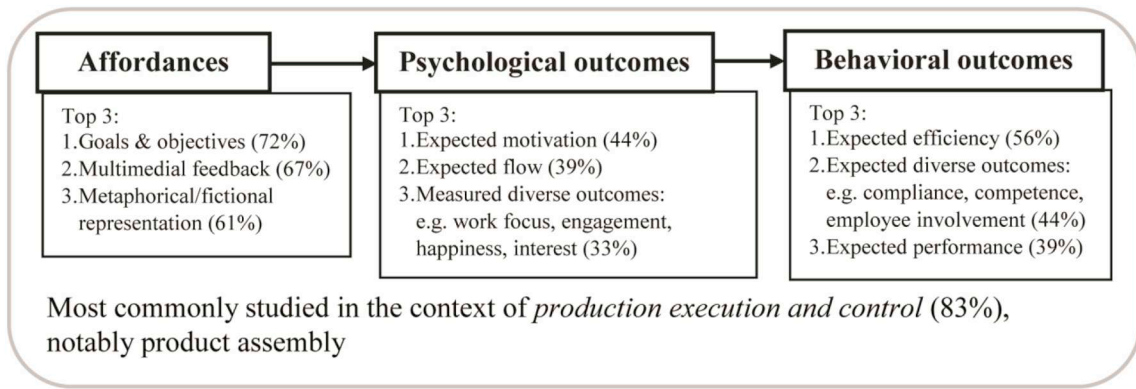


Fig. 3. Key results of the literature review, following our analytical framework.

Table 1

Sub-branches of production and logistics connected to applied research methodologies in the reviewed studies. The A-numbers refer to Appendix IDs.

	Design-conceptual or theoretical studies	Empirical, design research studies	
		Evaluation study	(Quasi-) experiment
Product and process engineering		A3	
Production planning	A17	A1	
Production execution and control	A6, A7, A9, A14, A15, A17	A1, A11	A4, A8, A10, A12, A13, A16, A18
Transportation planning and execution	A2	A5	

number of design iterations that involved basic product assembly work in sheltered work organizations. Here, motion recognition technology was applied to automatically ascertain which step in the assembly process was already done, and a projector was used to present visual feedback on the work table (A11–A13). The most common sectors of industry in the reviewed literature were the automotive and construction industries. In the automotive industry, gamification was mainly targeted at a variety of assembly tasks. In the construction industry, gamification was mainly targeted at work planning.

Other studies, besides the studies concentrating on the category production execution and control, were either more generally oriented on (a sub domain of) production and logistics and focused on an aspect of transportation planning and execution (e.g. improving truck driving efficiency by integrating different sensors in a single smartphone app that reports achievements and other feedback) or were focused on the particular sub domain of product and process engineering (e.g. complex event processing in any applicable production process). Supply chain design and planning was in general not covered in this final selection of studies, at least not on the actual primary process level. There is nevertheless one noteworthy management-level study (thus not included in the final selection) that examined gamification of global production chains (Potente, Varandani, & Prote, 2013). In this paper the problems regarding the upper managements' IT solutions for handling global production are discussed, and a gamified solution is suggested.

Looking at Fig. 3 from a methodological perspective, most of the reviewed papers (11 out of 18 studies) were empirical studies, based on design research. In other words, starting from one or more prototypes, these design solutions were subsequently tested in an evaluation study or a (quasi-) experiment (see Table 1). While the empirical nature of these studies is obvious, they only involved a small number of participating subjects at most. Of the 11 empirical studies, those that report a

sample size had a minimum of 5 and maximum of 60 participating subjects. The average sample size was 26.6 and the median sample size 22. It is noteworthy that most of the evaluation and experimental work had been conducted in the actual work environments. Only a few studies were conducted in a laboratory setting, involving Lego bricks, for example, to simulate the participants' work.

The remaining seven publications were also design-oriented in nature but have an additional conceptual or theoretical orientation. Moreover, these studies did not specifically report on the results of testing or evaluating a gamified solution, even though some of these publications do report empirical data gathered through interviews with stakeholders. These studies have, however, not been categorized as empirical papers in this review. The conceptual/theoretical papers most often present a design concept or prototype and discuss it in terms of, for example, psychological theories on motivation and flow; applicable (game-)technological advancements, in motion and emotional recognition processes or in context-sensitive hardware and software; and the state-of-the-art knowledge in the branch or the production and logistics aspects that are addressed.

In view of the research methods used, the papers reporting empirical studies mostly concern quantitative methods (7 out of 11 studies). Furthermore, two studies were conducted with mixed methods, one with only qualitative methods, and one study reported a simulation.

4.1. Applied or considered motivational affordances

In much of the gamification research and in many applications, the 'points, badges and leaderboards' triad has been a common way of implementing gamification, despite the calls from scholars to widen the perspective. They urge to consider the actual motivational aspects of the behavior that gamification is attempting to support (Deterding, 2015; Hamari et al., 2014; Morschheuser et al., 2017; Seaborn & Fels, 2015). Within the literature on gamification of production and logistics, the 'points, badges and leaderboards' triad is also present among the applied affordances, but these three elements are not the most commonly implemented ones (see Table 2).

Notably, the most commonly applied affordances in the body of literature are 'goals and objectives', followed by 'multimedial feedback', and 'metaphorical or fictional representations'. The concept of 'goals and objectives' refers to any consecutive goals or objectives that subjects feel capable of understanding and pursuing immediately. The concept of 'multimedial feedback' refers to the presentation of quick, immediate, and very brief normative feedback of the subjects' behavior, including any form of visual, audio, or textual feedback. The concept of metaphorical or fictional representations refers to audiovisual representations of the work process or the work environment concerned, for example, representing assembly work by Tetris (see e.g. studies A12 and A15).

Table 2
Motivational affordances applied or considered. The A-numbers refer to Appendix IDs.

Motivational affordance category	Number of publications
Goals and objectives	13 (A1, A3, A4, A6, A7, A10, A11, A13, A14, A15, A16, A17, A18)
Multimedial feedback	12 (A1, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A17)
Metaphorical or fictional representation	11 (A6, A7, A9, A10, A11, A12, A13, A14, A15, A16, A18)
Levels, progress	9 (A1, A5, A7, A9, A10, A11, A13, A14, A17)
Points, credits, achievements, rewards	9 (A1, A3, A4, A5, A8, A9, A16, A17, A18)
Competition, leaderboards, ranking	5 (A1, A3, A4, A5, A17)
Social elements	3 (A1, A4, A17)
'Shadowing' (previous performance visualization)	2 (A6, A15)
Suggestions, advice	1 (A5)
Unspecified	1 (A2)

It is interesting with regards to gamification literature in general that in the body of literature of this review the 'points, badges and leaderboards' triad of related affordances only comes in the fourth, fifth and sixth place of the most commonly applied affordances (Hamari et al., 2014; Seaborn & Fels, 2015).

Given the type of the work that the gamification was most often targeted towards in the body of literature in this review, the prevalence order of the elements indicated in the analysis is, however, quite understandable. According to the reviewed papers, the work was mostly individual, well-defined, step-by-step, and thus easily allowing for the definition of multiple, intermediate objectives and goals as well as for providing (multimedial) feedback. Furthermore, this could also explain, for example, the lack of the use of social aspects, even though they are very common in gamification solutions today (Seaborn & Fels, 2015). Individual work at least suggests an individual focus rather than a social and communal one.

It should also be noted that many of the studies (notably papers A3, A6, A9, A14, A15, A16, and A18) offer only a limited insight into the motivational affordances that are applied or considered. In these studies the design descriptions were often quite unclear or offered on a very general level. One study did not even specify any motivational affordances at all (study A2).

Table 3
Psychological outcomes connected to behavioral and organizational impacts in the reviewed studies. The A-numbers refer to Appendix IDs.

Behavioral/organizational impact		Expected			Measured		
		Performance	Efficiency	Other ^a	Performance	Efficiency	Other ^b
Psychological outcome Expected	Unspecified						A3
	Motivation	A6, A7, A9, A17	A2, A6, A7, A14, A17	A2, A9, A14, A17	A12	A4, A12	
	Flow	A6, A9, A13	A6, A13, A14, A15	A9, A14	A8, A12	A8, A12	
	Enjoyment/'fun'		A15				
Measured	Other ^c	A6	A5, A6	A5			
	Motivation	A10	A10	A16			
	Flow			A18			
	Enjoyment/'fun'	A10, A11	A10, A11				
	Emotional state			A18	A8	A8	
	Other ^d	A10, A11, A13	A10, A11, A13	A1, A16, A18	A1		

^a Including compliance, competence, employee involvement or turnover, job satisfaction, health, safety and communication.

^b Including system/technology performance or efficiency, and work transparency.

^c Including alertness/presence of mind, awareness, and learning.

^d Including work focus (not being disturbed), engagement, happiness, interest, perception of cognitive demand, physical demand, time pressure, performance and frustration.

4.2. Psychological outcomes and behavioral or organizational impacts

Table 3 lists psychological outcomes (expected or measured; the table's rows) and connects them to behavioral or organizational impacts (expected or measured; the table's columns) in each of the reviewed studies. Each cell references the individual publications that cover the particular outcome and impact.

With regard to psychological outcomes, 10 out of the 11 design research studies were either interested in, or had measured in some form, an increase in motivation, enjoyment (fun) or flow among the individual employees using the gamification. In case these concepts were actually measured as part of the studies, they were often measured via (self-developed) self-assessment questionnaires. Other psychological outcomes considered in the review of this body of literature include alertness or presence of mind, awareness, learning, work focus (not being disturbed), engagement, happiness, and interest.

With regard to behavioral or organizational impacts, 9 out of the 11 design research studies were either interested in, or had measured in some form, an increase in performance or efficiency, mostly on the level individual workers. The studies were mainly either per employee or overall predominantly concerned with improvement in quality of the product (less errors made during production), improvement in the number of products produced within some timeframe, with fewer resources required for production or transportation. Other behavioral or organizational impacts considered in this body of literature include compliance, competence, employee involvement or turnover, job satisfaction, health, safety, communication, system and technology performance or efficiency, and work transparency. Overall, the publications focus much more on individual behavioral impacts than on organizational impacts.

Several papers (most notably studies A14 and A18) make suggestive remarks about expected behavioral or organizational impacts. However, it was not explicitly stated whether these expected impacts were considered to be part of the goal of the gamification process, or just a means of arguing in favor of exploring gamification as an option. In Table 3, these notions are included as expected impacts nonetheless.

In terms of the results of the studies, 9 out of the 11 empirical studies report their findings. Most of these studies report positively-oriented findings (6 out of the 9 studies: A1, A4, A10, A11, A16, A18). The remaining three studies report some positive results, but also null or negative results (studies A8, A12, A13). The two empirical studies without actual findings include a preliminary user study that did not manage to present a comprehensive report of its results (study A5) and a simulation study (study A3).

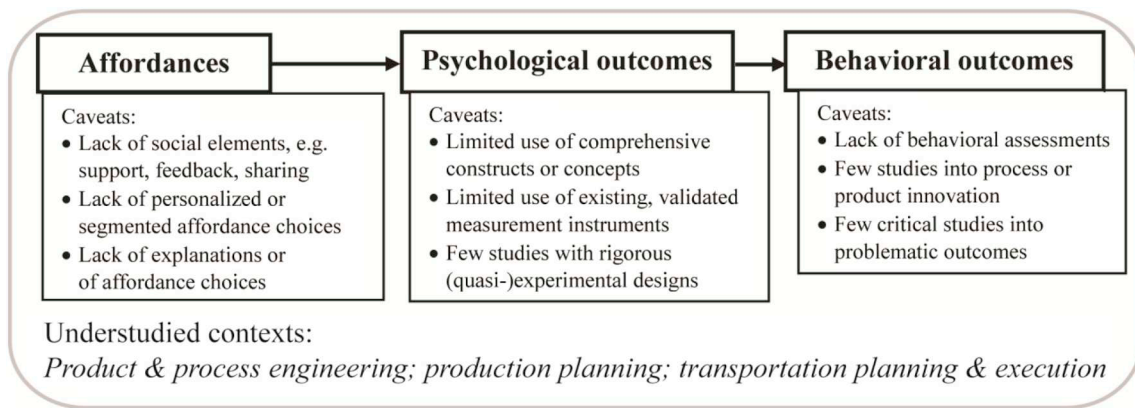


Fig. 4. Key critiques on the state of this field, following our analytical framework.

5. Discussion

Fig. 4 summarizes critical points of discussion that are raised throughout this section, within the applied analytical framework of the literature review. The critiques come from two perspectives. First, a perspective based on the status quo of this particular domain and the design research discipline in which 18 studies have been positioned. Subsequently, additional critiques are based on the perspective of a number of new disciplines within this domain, particularly by the discipline of management theory and critical studies.

5.1. Beyond piloting: more theory-driven experiments needed

Based on the review of the body of research literature on gamification of the work floor, it can be concluded that the research on the topic is currently in an early pilot phase. Several reasons have led to this conclusion, mainly with regard to the methodological and theoretical aspects of these studies.

Firstly, only a slight majority of the reviewed studies conducted actual tests, and only a few studies applied rigorous experimental research designs. With regard to these (quasi-) experiments, it should also be noted that sample sizes were fairly small, measurements were mostly conducted with instruments that had not been validated, and statistical significance was practically never achieved. Moreover, it is important that future studies with (quasi-) experimental designs compare the proposed gamification solutions to the actual existing work standard or arrangement rather than to laboratory conditions.

Secondly, as Table 3 shows, only one publication addressed the measurement of both psychological outcomes and behavioral and organizational impacts in the same study. This means that all the other studies did not explore the full chain of the gamification process, the affective as well as the behavioral outcomes included. Based on this finding, it can be concluded that the empirical research designs in the studies investigated were generally not very comprehensive. This is a limitation commonly noted in gamification research (Deterring, 2015; Hamari et al., 2014; Seaborn & Fels, 2015) that should get more attention in future research endeavors.

Thirdly, in-depth discussions about discrepancies between expected and observed effects or about ramifications on observed effects are very rare. Such discussions are limited to the discrepancy between the expected emotional state (less negative, more positive) and the observed emotional state of participants (less negative and positive) when comparing the gamified condition with the control condition (study A8).

Consequently, more experiments with theory-driven research designs are required (see e.g. Kriz & Hense, 2006; Mayer et al., 2014) that connect well-measured, more comprehensive psychological outcomes to equally well-measured, more comprehensive behavioral or organizational impacts. This allows the domain to better connect to

psychological theory in particular and should also allow for more in-depth discussions of discrepancies or nuances between expected and actual outcomes.

5.2. More comprehensive designs needed

This review also highlights another important point for future research to be considered, that is, where should the line be drawn between what constitutes gamification in a given context and what should be considered a motivational affordance or an important work/organizational design choice in a more traditional perspective. An example of such a challenge comes from the study A17, where it is demonstrated that construction planning and control require intermediate goals and objectives at all times; they are inherent to planning and control work. Thus, the domain has either been ‘gamifying’ the work already long before the term gamification became fashionable, or setting intermediate objectives and goals is not a particularly defining characteristic of gamification in this context.

In the domain of production and logistics, it seems that gamification has so far been predominantly understood quite simplistically, deterministically and instrumentally. Consequently, gamification has been approached in this domain without clearly specifying the motivational affordances, the undesired, expected or measured psychological outcomes, or the desired behavioral and organizational impacts. Indeed, this review found studies that reveal the instrumental appropriation of gaming elements in production and logistics. Yet, gamification is always designed and applied with a specific purpose in mind by someone, somewhere (though not always made very explicit). For example, one could gamify the work ‘as is’ (e.g. add a scoring system and leaderboard) or start ‘from scratch’ and design a new way of working from a gamification perspective. This means that it is important to be at least cautious and skeptical towards generic causal or correlational statements pertaining to gamification; more specific claims are in order about specific choices in gamification design, context and application. Even then it is important to contextualize the claims that are made - what theoretical or philosophical underpinnings are assumed, are these assumptions shared by the research participants, and what alternative underpinnings would shed a different light on the subject?

The field of gamification research and development is encouraged to aim for more than performance or efficiency with the gamification designs and to target more ambitious outcomes, such as process or product innovation. The field can also seek for a more tailor-made kind of gamification: gamification that can be personalized more to better suit the different backgrounds and needs of its participants. From a technological point of view, advances made over the past decade allow computer games to adjust their rulesets, based on the continual assessment of players’ competences or motivation levels. Similar

approaches could be adopted in the gamification of the work floor. This is not only a technological possibility, but it should arguably also be a design-theoretical necessity. Gamification designers and researchers need to know, and put into practice, the advances in psychology studies that stress the existence of individual, group and cultural differences in motivation (Hamari et al., 2018). Put simply: one size does not fit all. Differences in intrinsic motivation and useful extrinsic motivations *within* one's target audience should not be forgotten or avoided; they should simply be assumed and catered to.

5.3. Bringing the social into gamification research

It has been observed that current research on gamification in the production and logistics domain is largely focused on individual outcomes; research is in particular related to production execution and control. Moreover, the conducted research mostly follows a design-evaluation approach, which is not surprising in a field still in an early pilot phase. But as the field of gamification research and development matures, new and important angles of research will become increasingly important. In a corporate context, gamification will most likely and primarily be geared towards transforming actual work processes, practices and routines. Hence, the examination of gamification of production and logistics from the perspective of management and organization research offers powerful opportunities that have practically remained untapped so far. This review raises awareness for three potential shifts of research focus that offer possibilities for advancing the field; a focus on corporations as research sites, in-depth qualitative research designs, and the interpretation of gamification's organizational outcomes within the framework of management theory.

5.3.1. Focus on corporations as research sites

As observed in the studies reviewed, and reflected by the analytical framework, the production and logistics work floor is at the very heart of 'serious business'. If this review is an indicator for the industry sectors that show an interest in gamification (i.e. in areas such as automotive and construction), then these are the conventional sectors often dominated by well-established, publicly listed companies. According to Barley and Kunda (2001), "Because work and organizing are so interdependent, eras of widespread change in the nature of work in society should lead to the emergence and diffusion of new organizational forms and institutions". Hence, the ultimate question of the impact of gamification on production and logistics comes down to how it is able to affect actual and ongoing aspects of work processes: how gamification is able to change actual practices, processes and routines. This is potentially a much more complex question than experiments, or even pilot projects, can answer. Gamification research and development will need to blend into organizations that inhabit complex webs of relationships, cultures and corporate histories. Hence, the ability of gamification research to explain novel forms of organizing would be enhanced by studying the actual, in-situ interactions of organizational agents operating in gamified settings (Vesa et al., 2017). What are the actual practices, processes, routines and cognitive sensibilities that shape and affect how groups, units and organizations operate and interact within such settings, rather than simply focus on separate individuals (Landers et al., 2018)? Indeed, does gamification 'deliver' on its promise of enhanced performance, and what else does it deliver when appropriated and domesticated in the daily work of the factory floor; the often highly structured and standardized work of production and logistics? Ultimately, it all comes down to the question of "What is really going on in corporations when they (attempt) to gamify work?"

5.3.2. In-depth qualitative research designs

If the intention is address the question of "what is really going on?", then gamification scholarship has to be where the rubber hits the road: on the factory floor, or even literally when it concerns transportation by road. Until now, gamification scholarship has often delivered

quantitative studies and experimental designs. However, in the future getting at the coalface of gamification will require close-up studies of gamification-in-action. This requires drawing on ethnographic field-work techniques, such as participation, observation and in-depth interviews (see e.g. Rosen, 1991; Van Maanen, 1979; Vesa & Vaara, 2014; Yanow, 2012). Requiring close-up studies will in particular be necessary when gamified redesign of aspects of work processes acquires legitimacy and becomes in due time a routine way of improving how work is organized. Qualitative methods will allow researchers to get closer to and appreciate the personal experiences of executives, managers and workers engaged with gamified routines and practices. However, qualitative methods will also allow researchers to identify and observe how such routines and practices develop idiosyncratically and interact with the general space of the work floor. This call as such is not surprising because just as gamification is often observed in conjunction with design processes, areas such as service design extensively employ ethnographic methods in day-to-day work. It should also be noted that this is not a call to get rid of quantitative or mixed methods research; the expansion towards qualitative research is rather intended as a way to enrich our insight into an expanding phenomenon. Still, if this call is followed up then the question becomes a mix of "How to make sense of all this new data?" and "Where does this lead us?"

5.3.3. Interpretation of gamification's organizational outcomes as management theory

It is important here to turn to management theory to search for frameworks that are better suited to understanding the gamification of productive and logistics work as the ongoing work in corporations. By focusing on cognition and collective sensemaking (Cornelissen & Werner, 2014; Kaplan, 2011; Weick, 1995) researchers are better able to grasp the constant interpretation and re-interpretation of work processes as happens both in groups and on the individual level. Thus, rather than trying to prove the possible effects, or let alone efficiency improvements of gamification, it becomes important to understand the cognitive work performed within and in relation to a gamified perspective on the work that is done. How do people collectively make sense of changes to production and logistics work processes that can be seen to include gamified aspects? How are such processes or elements able to change how groups of people value their own work and how they approach tasks at hand? What are the moral and ethical consequences of this in the long run? Largely, these questions come down to understanding gamification as a type of organizational change; as one organizational (re-)design phenomenon alongside any other. Thus, scholars can learn more about the consequences of gamification by examining how phenomena such as managerial everyday coping (Rouleau, 2005; Samra-Fredericks, 2003), strategic change (Balogun & Johnson, 2005), or organizational (re)design (Denis, Dompierre, Langley, & Rouleau, 2011) have been analyzed and by appropriating frameworks and research designs from such studies. Scholars are encouraged to analyze and elucidate on how exactly gamification can be integrated into production and logistics and identify the clashes between the serious, work floor level practices and the playful aspects in organizational practice. Also, as indicated earlier in this review, the production and logistics work tasks sometimes contain self-sustained gamified qualities already. Research should pay attention to how these can be targeted in gamification or alternatively should be left untouched.

It should also be noted that the intermingling of work and play is not always unproblematic. Playfulness runs the risk of being merely seen as a device for efficiency or even coercion (Sørensen & Spoelstra, 2012). Gamification can be seen as a self-serving device for its proponents (Bogost, 2015); and gamification's ability to invoke intrinsic motivation is as such an invitation to exploitative behavior. If Huizinga's (1952) idea that play equals freedom is accepted, then structuring necessary work processes and practices into something playful or gamelike is questionable. Indeed, it is quite possible that

what actually happens under gamified conditions deviates from the intentions of its designers as different stakeholder groups (i.e. managers, designers, experts, or workers) appropriate and reinterpret the game-at-hand. This may result in turning the gamified aspect of work into a contested space through which power, conflict and resistance is ‘played’ out. Gamification in that sense is thus likely to be highly contested because calls for the reshaping of professional identities, established working routines and communities of practice (Wenger, 1998). Hence, it is important to encourage gamification scholars to engage more profoundly with critical theory to understand the potentially problematic nature of the topic. What exactly is the underlying motive for rendering the rather traditional working life of production and logistics into something playful? Such changes transform organizational discourses and practices; what is true and what can be talked about within the organizational frames (Knights & Morgan, 1991). Gamification can have substantial impacts on how work is valued, how strategies are formed and how power is exercised in the rather classical organizational contexts of production and logistics. It is here that we can start to elucidate on the socially profound aspects of our new-found love for ludus.

6. Conclusions

In summary, most of the 18 papers that were identified for the review were empirical, design research-based studies into production execution and control, for example, seeking to influence workers completing their task in the actual production process. The most commonly applied affordances in the studies were ‘goals and objectives’, ‘multimedial feedback’, and ‘metaphorical or fictional representations’. The use of metaphorical or fictional representations of the work as well as the ‘shadowing’ of previous work sessions (visualizing the worker’s previous or recent work performance as a shadow behind the worker’s current work performance to help setting a benchmark) is especially noteworthy since they have not been addressed in previous reviews of gamification in contexts other than production and logistics (Hamari et al., 2014). Most design research studies were either interested in, or

in some form measured through self-assessments, an increase in motivation, enjoyment (fun) or flow among the individual employees using the gamification. Furthermore, most were either interested in or measured an increase in performance or efficiency on the level of an individual worker, for example, an improvement in quality of the product being produced (less errors during the production process), improvement in amount of products produced in a particular timeframe, or fewer resources required for the involved production or transportation processes.

Finally, several considerations were discussed for improving and extending design research methodologies, all focused on increasing the clarity and rigor of the research. It was also suggested that the influx of organization theory into the domain, notably with regard to sense-making and critical-theory perspectives, was to draw attention to the various interpretations possible by those being subjected to a gamification process, as well as those designing and studying the gamification. The intermingling of work and play in post-bureaucratic models of work processes is not unproblematic, and a better understanding of this phenomenon requires new perspectives and associated qualitative methodologies that have mostly been untapped as yet.

Regarding the limitations of this review, it should be stipulated that the literature search was limited only to the Scopus database. While being confident of the comprehensiveness of the literature search, it is nevertheless possible that some relevant publications have been missed due to either not being indexed in this database or due to indexing errors (as is the case with any review study). However, it is certain that the potential number of missed publications is small, and their inclusion would not significantly affect the results of the review.

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Appendix A. Full list of the reviewed publications

ID	Full citation
A1	Cunha Leite, R. M., Costa, D. B., Neto, H. M. M., & Durão, F. A. (2016). Gamification technique for supporting transparency on construction sites: A case study. <i>Engineering, Construction and Architectural Management</i> , 23 (6), 801–822.
A2	Hense J., Klevers M., Sailer M., Horenburg T., Mandl H., Günthner W. (2014) Using gamification to enhance staff motivation in logistics. <i>Lecture Notes in Computer Science</i> , 8264, 206–213.
A3	Herzig, P., Wolf, B., Brunstein, S., & Schill, A. (2013). Efficient persistency management in complex event processing: A hybrid approach for gamification systems. <i>Lecture Notes in Computer Science</i> , 8035, 129–143.
A4	Kampker, A., Deutskens, C., Deutschmann, K., Maue, A., & Haunreiter, A. (2014). Increasing ramp-up performance by implementing the gamification approach. <i>Procedia CIRP</i> , 20, 74–80.
A5	Klemke, R., Kravcik, M., & Bohuschke, F. (2014). Energy-efficient and safe driving using a situation-aware gamification approach in logistics. <i>Lecture Notes in Computer Science</i> , 8605, 3–15.
A6	Korn, O. (2012). Industrial playgrounds: How gamification helps to enrich work for elderly or impaired persons in production. Paper presented at the 2012 ACM SIGCHI Symposium on Engineering Interactive Computing Systems, June 25–26, Copenhagen, Denmark.
A7	Korn, O., & Schmidt, A. (2015). Gamification of Business Processes: Re-designing work in production and service industry. <i>Procedia Manufacturing</i> , 3, 3424–3431.
A8	Korn, O., Boffo, S., & Schmidt, A. (2015). The effect of gamification on emotions: The potential of facial recognition in work environments. <i>Lecture Notes in Computer Science</i> , 9169, 489–499.
A9	Korn, O., Funk, M., & Schmidt, A. (2015). Assistive systems for the workplace: Towards context-aware assistance. In Information Resources Management Association (ed.), <i>Gamification: Concepts, Methodologies, Tools, and Applications</i> (pp. 1936–1949). Hershey: IGI Global.
A10	Korn, O., Funk, M., & Schmidt, A. (2015). Design approaches for the gamification of production environments: A study focusing on acceptance. Paper presented at the 8th ACM International Conference on Pervasive Technologies Related to Assistive Environments, July 1–3, Corfu, Greece.
A11	Korn, O., Funk, M., & Schmidt, A. (2015). Towards a gamification of industrial production: A comparative study in sheltered work environments. Paper presented at the 7th ACM SIGCHI Symposium on Engineering Interactive Computing Systems, June 23–26, Duisburg, Germany.

- A12 Korn, O., Funk, M., Abele, S., Hörz, T., & Schmidt, A. (2014). Context-aware assistive systems at the workplace: Analyzing the effects of projection and gamification. Paper presented at the 7th International Conference on Pervasive Technologies Related to Assistive Environments, May 27–30, Rhodes, Greece.
- A13 Korn, O., Lang, J., Korge, A., Causegic, H., & Schmidt, A. (2016). Gamification of a workday: A study on the effects in sheltered employment. Paper presented at the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, May 7–12, San Jose, USA.
- A14 Korn, O., Muschick, P., & Schmidt, A. (2017). Gamification of production? A study on the acceptance of gamified work processes in the automotive industry. In: Chung W., Shin C. (eds.), *Advances in Affective and Pleasurable Design. Advances in Intelligent Systems and Computing*, vol 483 (pp. 433–445). Cham: Springer.
- A15 Korn, O., Schmidt, A., & Hörz, T. (2012). Assistive systems in production environments: Exploring motion recognition and gamification. Paper presented at the 5th International Conference on Pervasive Technologies Related to Assistive Environments, June 6–8, Heraklion, Crete, Greece.
- A16 Lee, J., Kim, J., Seo, K., Roh, S., Jung, C., Lee, H., ... Ryu, H. (2016). A case study in an automotive assembly line: Exploring the design framework for manufacturing gamification. In: Schlick C., Trzeciński S. (eds.), *Advances in Ergonomics of Manufacturing: Managing the Enterprise of the Future. Advances in Intelligent Systems and Computing*, vol 490 (pp. 305–317). Cham: Springer.
- A17 Neto, H.M., Leite, R.M., Costa, D.B., & Durão, F. (2014). Visual Communication Panels for Production Control Using Gamification Techniques. Paper presented at the 22nd Annual Conference of the International Group for Lean Construction. June 25–27, Oslo, Norway.
- A18 Roh, S., Seo, K., Lee, J., Kim, J., Ryu, H. B., Jung, C., ... Shin, J. (2016). Goal-based manufacturing gamification: Bolt tightening work redesign in the automotive assembly line. Paper presented at the AHFE 2016 International Conference on Human Aspects of Advanced Manufacturing, July 27–31, Walt Disney World®, Florida, USA.

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