GAMIFICATION OF WAREHOUSING: EXPLORING PERSPECTIVES OF WAREHOUSE MANAGERS IN THE UK

(ACCEPTED MANUSCRIPT)

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Abstract

Contemporary warehouses are key links in the supply chains in competitive global business environments and with rapidly evolving trends in technology they need to adapt to the evolving needs of customers. Gamification recently emerged as a potential means of improving employee engagement leading to increased operational efficiency. This article therefore explores the perspectives of warehouse managers in the UK on gamification of warehousing activities. The findings suggest that gamification is applicable in the warehousing context with potential benefits such as improved worker engagement, increased morale and productivity, enforced competition, increased accuracy, and skills development. However, there are also significant barriers to effective implementation – these include resource constraints, gamification efficacy over time, ethical considerations, and ensuring fairness for all players. The findings from this study provide some valuable insights, thereby providing a rational basis for potentially fruitful future research in this area of growing interest.

Keywords

gamification, warehouse, warehousing, supply chain, logistics

Abstract

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1. Introduction

Contemporary warehouses are key links in the supply chains in competitive global business environments. In this context, there is a need for continuous improvement in all aspects of warehouse efficiency and productivity (Richards, 2011). Rapidly evolving trends in warehousing and distribution processes and technology need to adapt to the evolving needs of customers with a view to delivering world-class, error-free levels of service (Frazelle, 2002). According to Keller and Keller (2014), any warehouse is only as good as its personnel and warehouse managers need to carefully consider the many factors that have the potential to increase employee motivation.

Gamification can be defined as “the presence or addition of game-like characteristics in anything that has not been traditionally considered a game” (Harris and O’Gorman, 2014, p.8). It has recently emerged as a potential

means of improving employee engagement as part of the warehouse re-design and improvement process (Korn and Schmidt, 2015). The exploratory research described in this paper aims to explore the perspectives of warehouse managers on gamification of warehousing activities and to compare practitioner perspectives with the body of academic knowledge.

Following this introduction, the authors' literature review first provides an overview of relevant extant literature on gamification in a logistics and supply chain management (LSCM) context before focussing on the major challenges facing warehouse managers and some of the motivational techniques used to stimulate productivity improvements. The potential benefits, challenges and applications of gamification are then discussed. This provides the basis for the rationale of the current study – this is explained and the authors' specific objectives are set out. The methodology employed to address these objectives is described in section 3. The authors discuss the key results and findings from the research in section 4 before highlighting some of the main limitations and contributions of the paper in section 5. Section 6 highlights some key messages from the research by way of conclusion.

2. Literature review

A review of the relevant extant literature was carried out with a particular focus on gamification in a LSCM context. The review process and keyword selection was informed by the recent literature review on gamification by Warmelink et al (2020). It uses several keywords – "gamification", "logistics", "supply chain" and "warehouse/warehousing" – to search the SCOPUS database. The SCOPUS database was selected for its quality standards, broad coverage of academic literature including leading LSCM journals and an ease of constructing search queries. The literature review process described in Section 2.1 demonstrates that a quite limited number of articles exist on the specific theme of this study. Therefore subsequent discussions are aided by the body of knowledge sourced from Google Scholar and Web of Science (Harzing and Alakangas, 2016), with Section 2.2 focusing on warehousing challenges and motivational techniques used to encourage productivity, then Section 2.3 discusses gamification benefits and challenges. The potential application of gamification in warehousing and the wider LSCM context is discussed in Section 2.4, leading to the development of our research objectives and questions.

2.1 Literature review process

In order to understand and review literature on the topic of gamification within LSCM context, a database search query was constructed by modifying and extending a set keywords found in Warmelink et al (2020). These keywords are "gamif*", "logistic*", "supply chain" and "warehous*" with an asterisk denoting a wildcard search (for example, gamification and gamify or warehouse and warehousing). For the sake of limiting findings only to peer reviewed journals and conference papers in the English language, search query limitations were added. Keywords and database respective queries and search limitations are presented in Table 1.

Table 1: Keywords and database search queries and limitations

Keywords	**Database search query**	**Limitations**
Logistic*	TITLE-ABS-KEY (gamif*) AND TITLE-ABS-KEY (logistic*) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))	Articles: peer reviewed journal and conference papers Language: English
Supply chain	TITLE-ABS-KEY (gamif*) AND TITLE-ABS-KEY ("supply chain") AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))	
Warehous*	TITLE-ABS-KEY (gamif*) AND TITLE-ABS-KEY (warehous*) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))	

The literature selection process utilized the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, Moher et al., 2009) four-tiered approach: identification, screening, eligibility and inclusion. A search in the SCOPUS database identified 49 articles matching the queries. During the screening two duplicates were removed with the remaining 47 articles then screened initially based on titles and abstracts, and subsequently on their full text using the eligibility criteria set out in Section 2.1.1. In order to guard against potential study selection bias in screening and eligibility assessment, the process was modelled after the

practice outlined by Lim et al. (2013), whereby the two authors independently evaluated the articles and reconciled any disagreements through debate and discussion until a consensus was reached. The literature selection process is shown in the PRISMA flow diagram in Figure 1.

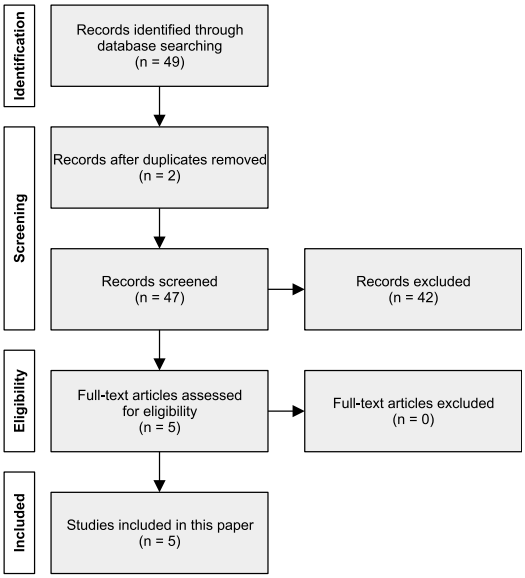

Figure 1: Literature selection process

2.1.1 Inclusion and exclusion criteria

The authors used a number of criteria to assess the eligibility if papers for inclusion. First, only peer-reviewed academic papers published in a journal or conference proceedings and written in English were considered. This criterion was achieved by using SCOPUS database limiters (DOCTYPE, LANGUAGE). Second, included articles had to be closely aligned with the topic of the study. Articles that did contain relevant keywords but did not pertain to the main topic of this study were excluded (some had a focus on, for example, the use of games in LSCM education). Third, the authors assessed the remaining papers for their quality using a checklist developed by Kmet et al. (2004). They also investigated the reputability of conferences as four out of five shortlisted articles were published in proceedings. Shortlisted articles included in this paper are enumerated in Table 2.

Table 2: Shortlisted articles

Reference	**Title**
Warmelink et al,. 2020	Gamification of production and logistics operations: Status quo and future directions
Putz et al., 2019	A vignette study among order pickers about the acceptance of gamification
Bräuer and Mazarakis, 2019	Badges or a leaderboard? How to gamify an augmented reality warehouse setting
Teras et al., 2016	NDiVE: Gamified virtual reality environment for logistics and supply chain management training
Remi-Omosowon et al., 2016	Applying gamification principles to a container loading system in a warehouse environment

Table 2 shows that only five articles were found to match the specific theme of this study and these form the basis of section 2.4. Sections 2.2 and 2.3 provide context for this by introducing warehousing and gamification themes that are particularly relevant in the context of the current study's focus.

2.2. Warehousing

Warehouses are considered a key part of the supply chain (Gu et al., 2007) and operations within warehouses are concerned with the efficient and effective flow of materials the specific core activities are: receiving, put-away, storage, order picking, and dispatching/shipping. Among these activities, order picking is the most labour-intensive and costly process at approximately 60% of total labour activities (Drury et al., 1988;

Gamberini et al., 2012) and constitutes approximately 55% of the total operating expenses (Roodbergen, 2001; Frazelle, 2002; Richards, 2011). Warehouse managers are under constant pressure to: minimise cost and time, reduce spoilage and increase efficiency (see, for example: Frazelle, 2002); consider environmental impact (see, for example: McKinnon et al., 2015; Fichtinger et al., 2015; Ries et al., 2017; Konur et al., 2017);manage warehouse space and layout (see, for example: Vrysagotis and Kontis, 2011; Cheung et al., 2009; Zupan et al., 2017);meet customer expectations (see, for example: Madurapperuma et al., 2018);and, efficiently manage warehouse personnel (see, for example: Keller and Keller, 2014; Kim et al., 2018).

According to Keller and Keller (2014), the warehouse is only as good as its personnel and warehouse managers need to consider factors affecting employees' motivation: achievement, recognition, growth, payment, feedback, rewards, and empowerment (Emmett, 2005; Tella et al., 2007; Kamalian et al., 2010; Manzoor, 2011; Capobianco, 2014). Increased motivation can improve performance and more recently gamification emerged as a potentially new way to improve morale and engagement.

2.3 Gamification

As noted in the introduction, gamification can be defined as "the presence or addition of game-like characteristics in anything that has not been traditionally considered a game" (Harris and O'Gorman, 2014, p.8). "Use of game design elements in a non-game context" (Deterding et al., 2011, p.9) improves productivity and performance by way of provoking basic human desires (see, for example: Burke, 2014; de-Marcos et al., 2014; Hamari, 2013; Papastergiou, 2009).

Typical elements of a gamified activity include (Dale, 2014; Korn and Schmidt, 2015; Kapp, 2012; Zichermann and Cunningham, 2011; Cardador et al., 2017):

- Points – distributed to players for high-value achievements or behaviours;
- Achievements – provide satisfaction for high-value user behaviour;
- Levels – highlight the level of engagement of each player and reinforce them for new challenges;
- Missions – are sets of behaviours which enable players to get specific rewards;
- Contests – specific rewards for players who finish effectively and quickly;
- Leader board – increase competition by posting rankings; and,
- Notifications – encourage players towards the desired action.

Gamification of business activities has a potentially positive impact on employees for a variety of reasons. These include, but are not limited to improved engagement, increased morale, faster learning and skills development, increased productivity, competition, and performance tracking (Narayanan, 2014; Dale, 2014; Marczewski, 2013; Burke, 2014). By providing levels, badges or other types of rewards and gaming elements, companies can actuate the employees' interest and engage them on a more personal level (Warnlof, 2014).

There are also a number of challenges facing gamification. Firstly, the effective implemention of gamification is a quite complicated business process. It requires detailed planning, thereby consuming not insignificant amounts of time and other resources (Harris and O'Gorman, 2014). Furthermore, the fact that individual players vary from each other in many ways challenges designers to develop a good understanding of that variability (Robson et al., 2015). For example, some players may be more interested in the social aspect of the gamified experience in order to learn more and interact with others, while others may be more competitive and thinking more about personal growth and achievement. As people differ from each other designers need to consider behavioural characteristics as an integral process of developing the mechanics of gamified processes (Werbach and Hunter, 2015). Some studies also indicate that gamification may not keep players motivated for a long time (Farzan et al., 2008; Hamari, 2013). This sometimes requires that the mechanism of the gamified experience be regularly changed in an effort to keep players motivated. Lastly, creating a competitive environment to increase engagement and motivation has some ethical implications as cheating in various guises can sometimes emerge (Jiang, 2011; Eyal, 2014).

2.4 Applications of gamification in warehousing and LSCM

While gamification has been successfully implemented in in jobs that are primarily office-based (for example: Freshdesk (Robson et al., 2016); DevHub (Kuo, 2015; Dale, 2014); Microsoft (Narayanan, 2014; Smith et al., 2015); and, Deloitte (Dale, 2014; Meister, 2013), there appear to be have been very few attempts to implement gamification within the warehousing and broader LSCM context. Putz et al., 2019 conducted a vignette study among warehouse order pickers about acceptance of gamification and concluded that it may be a suitable

approach to increase motivation and performance. However, experiments with gamification badges and leader boards in a warehouse setting indicated that while there are benefits to be gained, the competitive game design elements can have an unintended negative side effects such as a feeling of incompetence among workers and associated decreases in motivation (Bräuer and Mazarakis, 2019). Two relatively recent studies suggest that gamification may be successfully used in various aspects of logistics workforce training. Teras et al. (2016) reported on successful training with gamified virtual reality (VR) scenarios for logistics staff, while Remi-Omosowon et al. (2016) applied gamification to training in container loading problems which empowered warehouse operatives to use optimal methods of loading without resorting to complicated optimization algorithms. Lastly, Warmelink et al (2020) reviewed extant literature on a broad theme of gamification in logistics and production operations concluding that it can have a significant impact on workflow and operational strategies, encouraging researchers to develop this emerging field of study. Thus, Warmelink et al (2020) echoed a statement from warehouse consultants Manhattan Associates that "we are still in the early stages of seeing gamification elements [embedded] in labour management systems, but it holds great promise as a tool to help revolutionize the warehouse workforce" (Schnorbach, 2015). As such, this indicates a gap within the current body of knowledge. It is this gap that the current work aims to begin to fill.

The literature review indicates the potential importance of undertaking some research aimed at generating deeper and richer insights into the practitioner perspectives on gamification of warehousing activities. Based on the above the specific objectives of this exploratory research study are to explore perspectives of warehouse managers on gamification of warehousing activities and to compare practitioner perspectives with the body of academic knowledge. The research questions (RQs) are set out as follows:

- RQ1: What is the applicability of gamification in warehousing?
- RQ2: What are the main potential benefits of gamification in warehousing?
- RQ3: What are the main potential obstacles to applying gamification in warehousing?

The nature of these RQs means that it is probably impossible to provide definitive responses to them. Their main role is, therefore, to ensure that the key issues identified in the literature review are addressed in logical and systematic way.

3. Research design

The authors developed a research design aimed at generating the required insights into their RQs. Section 3.1 outlines the key elements of the author's overall research strategy Section 3.2 then describes how the required qualitative data will be collected with section 3.3 then highlighting some of the key analytical considerations.

3.1 Overall research strategy

As noted above, the purpose of this article is to gain deeper and richer insights into the practitioner perspectives on gamification of warehousing activities. As indicated by the literature review, the relative scarcity of work in this specific area means that the current study is primarily exploratory in nature. By employing a pragmatic philosophical approach and mainly inductive approach, the authors plan to contribute to conceptual understanding of the role of gamification in warehousing rather than making claims to empirical generalizability (Croom at el., 2000). To generate the required insights, the authors conducted interviews with warehouse managers working in the UK. In essence, this approach adopts the lesson of Geertz (1973, p.5) who stated that "if you want to understand what a science is, you should look in the first instance not at its theories or its findings ...you should look at what the practitioners do".

3.2 Data collection

The author's data collection used focussed (i.e. semi-structured) interviews. Semi-structured interviews lend itself well to "examining [an] uncharted territory with unknown but potential momentous issues" and give a chance to the "interviewers to spot useful leads and pursue them" (Newcomer et al., 2015). The interview sample comprised eight warehousing managers with at least four years relevant working experience. The UK is a suitable context for this research given its importance in the wider European and international logistics landscape and its relatively highly developed logistics infrastructure as indicated in the World Bank Logistics Performance Index (Arvis et al., 2016). The relatively small sample of interview respondents mirrors data collection guides of other studies where insights from a pool of experienced practitioners were sought (see, for example: Lummus et al., 2001 who used six; Rhodes at al., 2005 who used ten). Table 3 presents some of the interviewees' characteristics.

Table 3: Interviewees' characteristics

Code	Position	Years of experience	Goods/services orientation	Company presence
WM1	Warehouse Manager	4 years	Warehouse solutions	UK
WM2	Warehouse Manager	13 years	Consumer goods	Global
WM3	Warehouse and Logistics Manager	24 years	Grocery stores	UK
WM4	Warehouse and Logistics Manager	13 years	Manufacturing and production solutions	UK
WM5	Warehouse Manager	12 years	Logistics services	Global
WM6	Warehouse Manager	27 years	Consumer goods	Global
WM7	Warehouse Manager	13 years	Furniture	UK
WM8	Head of Logistics	10 years	Consumer goods	Global

This sample of companies handles a wide variety of product groups thus enabling the authors to generate a breadth of perspectives. Individual respondents were in senior positions with responsibilities for warehouse management. Each person was sent information about the authors' RQs as an indication of topics to be discussed during their upcoming interviews. The research then involved carrying out focussed (i.e. semi-structured) interviews with each respondent. The core of each interview was built around the RQs. Interviews were recorded and transcribed.

3.3 Data analysis

Easterby-Smith et al. (2008) describe two approaches to analysis of interview data: content analysis and grounded analysis. Data analysis process in this work involves a combination of both methods. The transcript analysis used by the authors is shown in Figure 2 and involved four main stages in distilling the raw transcript data into information that was analysed based on comparing and contrasting the main issues set out by respondents. This comparing and contrasting essentially involves the identification of both points of convergence and divergence among the responses provided.

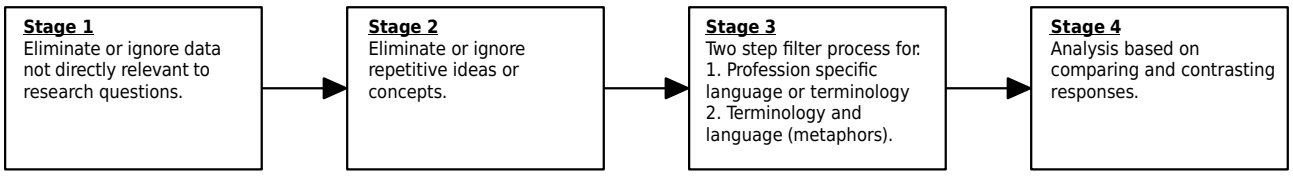

Figure 2: Transcript analysis process

4. Findings and discussion

As noted above, the authors three research questions (RQs) were developed primarily to ensure that all facets of interest were addressed. The following sections highlight the main issues that emerged from the eight interviews in relation to each RQ. In each case, the empirical findings from the interviews are related back to the relevant issues from the extant literature.

4.1 RQ1: Applicability of gamification in warehousing

RQ1 asks about the applicability of gamification in warehousing. In this context, the majority of warehouse managers support a view that order-picking is the most labour-intensive and costly activity (WM2, WM3, WM4, WM6, WM7 and WM8), which is in line with academic literature (see, for example: Frazelle, 2002; Coyle et al., 2002; Tompkins et al., 2010; Richards, 2011; Van Den Berg, 2012; Gamberini et al., 2012). However, WM1 pointed out that quality control is the most labour-intensive and costly activity in his business, as a bad quality product can lead to dissatisfied customers and negative reviews being disseminated online. Furthermore, for WM5 it is the training of employees that is most costly and labour intensive due to high forklift and crane training costs, and the required health and safety precautions during the training sessions. The most monotonous and boring warehouse activities for personnel were order-picking (according to WM2, WM3, WM4, WM5 and WM8), loading of trucks (WM7), crane driving (WM6) and quality control (WM1). In these activities workers usually perform the same movements and tasks with little variety, with attendant

declines in work performance is directly linked to motivation levels (Emmett, 2005). All managers indicated that money and rewards were crucial motivational factors for their employees (Tella et al., 2007). As such, all interviewees highlighted that those warehousing activities often considered mundane would be applicable for gamification.

Gamification can increase employees' productivity, engagement and morale (Narayanan, 2014; Dale, 2014; Marczewski, 2013; Burke, 2014) and this was the perception of the majority of interviewees (WM1, , WM3, WM4, WM5 and WM8). WM5 and WM7 stated that gamification may be a way to develop "a fun environment" which will boost employee morale and create a healthy competitive environment (WM1, WM2, and WM8). WM5 even speculated that having better motivated and more engaged employees can increase the quality of any given task. However, WM6 warned that workers would not like to be ranked and identified on a leader board, as he has tried a similar tactic in the past and workers protested against it, which corroborates the findings of Robson et al (2015) and Bräuer and Mazarakis (2019). While all respondents s agreed that gamification may be applicable to warehousing environments, they were generally cautious about potential benefits (RQ2) and envisaged several implementation obstacles (RQ3).

4.2 RQ2: Gamification benefits

RQ2 asks about the main potential benefits of gamification in warehousing. Gamification benefits that can potentially be achieved in business environments in general include increased employee productivity, increased engagement and morale, competitive environment, easier performance tracking, better feedback, skills development and employee learning (Narayanan, 2014; Dale, 2014; Marczewski, 2013; Burke, 2014). Interview data from warehouse managers corroborated these potential general benefits in warehousing environments specifically, as well as suggesting some additional more specific benefits. Interviewees suggested that the main potential benefits of gamification will be in increased productivity and morale (WM1, WM3, WM4, WM5 and WM8). Furthermore, the development of "a fun environment" to work in (WM5 and WM7) and a healthy level of competition between employees (WM1, WM2 and WM8) were highlighted as the factors that could lead to achieving these benefits. Interestingly, the majority of interviewees were much more interested in discussing potential obstacles (RQ3).

4.3 RQ3: Gamification obstacles

Gamification literature enumerates a number of challenges and obstacles such as tolerance with time, ethical implications, resources and differentiation of players (Harris and O'Gorman, 2014; Robson et al., 2015; Werbach and Hunter, 2015; Farzan et al., 2008; Hamari, 2013; Jiang, 2011; Eyal, 2014) and interviewed warehouse manager also shared these concerns. As well confirming that these general concerns are widely shared in warehousing environments, interviewees raised a number of other issues.

WM1, WM2 and WM7 stated that strict budget limitations will certainly be difficult to overcome. A successful gamification needs intensive planning, time and resources to be well designed and implemented (Harris and O'Gorman, 2014) and managers predicted that implementing it will not be a priority within their financial constraints.

Another obstacle mentioned by WM1, WM2 and WM8 is the sustainability of gamification over time. This relates to the concern that as employees/players fulfil their personal satisfaction needs their incentive levels simultaneously reduce, thereby lessening its impact and attendant ability to motivate staff. This view corroborates with existing literature which suggests that gamification may not keep players motivated for long periods (Farzan et al., 2008; Hamari, 2013).

Ethical issues surrounding gamification appear to represent a serious challenge to its application in warehousing. WM1, WM2, WM3 and WM5 noted a number of ethical concerns related to employee behaviour. These included, but are not limited to: cheating, neglecting health and safety procedures, extreme risk-taking and other unethical actions aimed at taking individuals quickly to the top of a leader board. Issues of bluffing and cheating, which may occur when gamification is applied within a business context were highlighted by Jiang, (2011) and Eyal (2014).In this context, WM1 mentioned that gamification systems must be fair for all employees. For instance, in order picking, pickers should have the same routes to traverse at the same level of difficulty and, the words of WM1, "it is not fair if one picker picks only heavy items at the back of the warehouse and the other only picks small items on the eye level racks at the front of the warehouse".

Interestingly, WM3 stated that while gamification can "positively affect the social life of workers while they feel that being valued for what they offer to the warehouse" it can also have a negative effect on underperforming workers. As such, it was suggested that any gamification system should be designed in a way that takes employee well-being and mental health into an account. This is in line with the work of Johnson et al.(2016)and also corroborates the findings of Bräuer and Mazarakis (2019). This suggests that that the competitive game design elements potentially have negative side effects such as a feeling of incompetence among workers and an attendant decrease in motivation.

Finally, all interviewees indicated that while gamification may be achievable at state-of-the-art warehouses with very good IT systems it will not be suitable for low-tech operations, which hints at a digital divide between large operators and their small and medium enterprise (SME) peers in the logistics sector (see, for example: Evangelista et al, 2013).

5. Research limitations and future work

Reflection on the validity and reliability of this research facilitates a clearer understanding of the main limitations of this exploratory study. This reflection was carried out through the lens of the four qualitative criteria recommended by Lincoln and Guba (1985) – credibility, transferability, dependability and confirmability.

The credibility criterion involves confirming that the results of qualitative research are credible from the perspective of the participants in the research. Whilst there is room for improvement in this area in the research described in this paper, one of its strengths is that in-depth discussions with key informants facilitates the development of fresh insights that reflect very accurately the issues being faced by practitioners. This was supported by inviting interviewees to comment on summaries of the research findings.

The small sample used in the current research is not intended to be definitive and transferability or generalisability is impossible, but in the exploratory context of this paper a small sample size rather than being a detriment achieves "a close association with the respondents, and enhances the validity of fine-grained, in-depth inquiry" (Crouch and McKenzie, 2006, p.483). Use of the focussed interview methodology enabled some potentially useful contributions to be developed inductively. The process of directly relating the empirical findings from the interviews back to the relevant extant literature helped in this regard. The next stage of the work is to build directly on our initial findings through empirically testing using a larger survey of warehouse managers. This will facilitate the development of more generalizable insights, thereby building directly on the contribution of this exploratory study.

Dependability in qualitative research emphasizes the need for researchers to account for the changing contexts within which research occurs. In this regard, the authors ensured that the complete empirical research process was comprehensively documented- from initial design through to analysis and feedback. This facilitates replication of the study in other contexts. From a LSCM perspective, it would be interesting to generate insights from other parts of the supply chain – i.e. procurement, manufacturing, transportation and retail. The current study was restricted to the UK for the reasons explained earlier. Another potentially fruitful avenue would involve the implementation of the current methodology in different geographical contexts. Given the importance of behavioural and other culture-related variables, such international data collection and analysis offers the opportunity to explore gamification applicability at the national/local nodes of increasingly international/global supply chain configurations.

Confirmability refers to the extent to which the results could be confirmed by others. Future work should build on the findings of this research using a combined inductive/deductive approach based on methodological triangulation. This builds on the larger scale surveys of warehouse managers referred to earlier by incorporating focus groups, case studies, action research and other appropriate elements into an overall integrated research design. The implementation of a methodologically pluralist design that uses mixed methods and data collection and analysis is the key to taking the current exploratory study forward.

Furthermore, the authors recognise a limitation of using solely SCOPUS database for their literature search. Future work on this topic would benefit by following the broadly recognised practice of using multiple databases for conducting systematic literature reviews (see, for example: Lim et al, 2013; Bremer et al, 2017).

6. Conclusions

The first objective of the research described in this paper was to explore perspectives and gain insights on gamification of warehousing activities, with the focus on its applicability, potential benefits and obstacles. To this end, the views of warehouse managers have been solicited through a series of focussed interviews. The findings suggest that gamification is applicable in the warehousing context with potential benefits such as improved worker engagement, increased morale and productivity, enforced competition, increased accuracy, and skills development. However, there are also significant barriers to effective implementation – these include resource constraints, gamification efficacy over time, the need for careful and detailed planning, ethical considerations, and ensuring fairness for all players. The findings from the current study provide some valuable insights, thereby providing a rational basis for potentially fruitful future research in this area of growing interest.

References

- Arvis, J.F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A. and Naula, T., 2016. *Connecting to Compete 2016: Trade Logistics in the Global Economy--The Logistics Performance Index and Its Indicators*. World Bank.
- Bramer, W.M., Rethlefsen, M.L., Kleijnen, J. and Franco, O.H., 2017. Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study. Systematic reviews, 6(1), p.245.
- Bräuer, P. and Mazarakis, A., 2019. Badges or a leaderboard? How to gamify an augmented reality warehouse setting. In GamiFIN (pp. 229-240).
- Burke, B. (2014) Gamify: How Gamification Motivates People to Do Extraordinary Things. Bibliomotion, Incorporated.
- Capobianco, E. (2014) Rewards and Recognition: The Keys to Motivating Your Team. Available at: https://thenextweb.com/entrepreneur/2014/10/09/recognizing-your-employees/ (Accessed: 15 July 2019).
- Cardador, M.T., Northcraft, G.B. and Whicker, J. (2017) A theory of work gamification: Something old, something new, something borrowed, something cool? Human Resource Management Review, 27 (2): 353–365.
- Cheung, M.Y., Choy, K., Tan, K., et al. (2009) The design of an RFID-enhanced autonomous storage planning system for 3PL warehouses. International Journal of Value Chain Management, 3 (1): 108–128.
- Coyle, J.J., Bardi, E.J. and Langley, C.J. (2002) The management of business logistics: a supply chain perspective. Mason, Ohio : South-Western, 2002.
- Croom, S., Romano, P. and Giannakis, M., 2000. Supply chain management: an analytical framework for critical literature review. *European journal of purchasing & supply management*, *6*(1), pp.67-83.
- Crouch, M., & McKenzie, H. (2006). The logic of small samples in interview-based qualitative research. Social science information, 45(4), 483-499.
- Dale, S. (2014) Gamification: Making work fun, or making fun of work? Business Information Review, 31 (2): 82–90. doi:10.1177/0266382114538350.
- de-Marcos, L., Domínguez, A., Saenz-de-Navarrete, J., et al. (2014) An empirical study comparing gamification and social networking on e-learning. Computers & Education, 75: 82–91.
- Deterding, S., Dixon, D., Khaled, R., et al. (2011) "From game design elements to gamefulness: defining gamification." In Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments. 2011. ACM. pp. 9–15.
- Drury, J., Warehouse Operations Special Interest Group. Order Picking Working Party, Turnbull, B., et al. (1988) Towards More Efficient Order Picking. IMM monograph. Institute of Logistics.
- Easterby-Smith, M., Thorpe, R. and Jackson P.R. (2008), Management Research: an introduction, (3 rd edition), London: Sage Publications.
- Emmett, S. (2005) Excellence in warehouse management : how to minimise costs and maximise value. Chichester, West Sussex, England ; Hoboken, N.J. : Wiley, ©2005.
- Evangelista, P., McKinnon, A. and Sweeney, E., 2013. Technology adoption in small and medium-sized logistics providers. Industrial Management & Data Systems, 113(7), pp.967-989.
- Eyal, N. (2014) The Pros And Cons Of A Gamified Work Culture. Available at: https://www.fastcompany.com/3035257/the-pros-and-cons-of-a-gamified-work-culture (Accessed: 22 July 2019).

- Farzan, R., DiMicco, J.M., Millen, D.R., Brownholtz, B., Geyer, W. and Dugan, C., 2008, April. When the experiment is over: Deploying an incentive system to all the users. In *symposium on persuasive technology*.
- Fichtinger, J., Ries, J.M., Grosse, E.H., et al. (2015) Assessing the environmental impact of integrated inventory and warehouse management. International Journal of Production Economics, 170: 717–729.
- Frazelle, E. (2002) World-class warehousing and material handling. Logistics Management Library. New York ; London : McGraw-Hill, ©2002.
- Gamberini, R., Rimini, B., Dell'Amico, M., et al. (2012) "Design and Optimization of Picking in the Case of Multi-Item Multi-Location Multi-Pallet Customer Orders." In Warehousing in the Global Supply Chain. Springer. pp. 397–424.
- García-Álvarez de Perea, J., García-Ramírez, C. and Cubo-Molina, D., 2019. Internationalization Business Models and Patterns of SMEs and MNEs: A Qualitative Multi-Case Study in the Agrifood Sector. Sustainability, 11(10), p.2755.
- Geertz, C. (1973), The Interpretation of Cultures, New York: Basic Books.
- Gu, J., Goetschalckx, M. and McGinnis, L.F. (2007) Research on warehouse operation: A comprehensive review. European Journal of Operational Research, 177 (1): 1–21.
- Hamari, J. (2013) Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. Electronic commerce research and applications, 12 (4): 236–245.
- Harris, S. and O'Gorman, K. (2014) Mastering Gamification: Customer Engagement in 30 Days. Birmingham, UK: Impackt Publishing.
- Harzing, A.W. and Alakangas, S., 2016. Google Scholar, Scopus and the Web of Science: a longitudinal and cross-disciplinary comparison. Scientometrics, 106(2), pp.787-804.
- Jiang, K., 2011. The dangers of gamification. Why we shouldn't build a game layer on top of the world.
- Johnson, D., Deterding, S., Kuhn, K.A., Staneva, A., Stoyanov, S. and Hides, L., 2016. Gamification for health and wellbeing: A systematic review of the literature. Internet interventions, 6, pp.89-106.
- Kamalian, A.R., Yaghoubi, N.-M. and Moloudi, J. (2010) Survey of relationship between organizational justice and empowerment (A case study). European Journal of Economics, Finance and Administrative Sciences, 24 (2): 165–171.
- Kapp, K.M. (2012) The gamification of learning and instruction: game-based methods and strategies for training and education. John Wiley & Sons.
- Keller, S.B. and Keller, B.C. (2014) The definitive guide to warehousing : managing the storage and handling of materials and products in the supply chain. Upper Saddle River, New Jersey : Pearson Education, [2014].
- Kim, T.Y., Dekker, R. and Heij, C. (2018) Improving warehouse labour efficiency by intentional forecast bias. International Journal of Physical Distribution & Logistics Management, 48 (1): 93–110.
- Kmet, L.M., Lee, R.C., Cook, L.S., 2004. Standard Quality Assessment Criteria for Evaluating Primary Research Papers. Alberta Heritage Foundation for Medical Research, Edmonton, Alberta, Canada.
- Konur, D., Campbell, J.F. and Monfared, S.A. (2017) Economic and environmental considerations in a stochastic inventory control model with order splitting under different delivery schedules among suppliers. Omega, 71: 46–65.
- Korn, O. and Schmidt, A. (2015) Gamification of Business Processes: Re-designing Work in Production and Service Industry. Procedia Manufacturing, 3: 3424–3431.
- Kuo, I. (2015) DevHub: Developing Consumer Engagement Through Gamification. Available at: http://www.gamification.co/2015/07/14/devhub-developing-consumer-engagement-through-gamification/ (Accessed: 03 July 2019).
- Lim, M.K., Bahr, W. and Leung, S.C., 2013. RFID in the warehouse: A literature analysis (1995–2010) of its applications, benefits, challenges and future trends. International Journal of Production Economics, 145(1), pp.409-430.
- Lincoln,Y. and Guba, E., 1985. Naturalistic Inquiry. NewYork, NY: Sage.
- Lummus, R.R., Krumwiede, D.W. and Vokurka, R.J. (2001), 'The Relationship of Logistics to Supply Chain Management: Developing a Common Industry Definition', Industrial Management and Data Systems, 101(8), 426–432.
- Madurapperuma, S., Ebert, L. and Kuruppuarachchi, D. (2018) In-house development & implementation of 'corebrain'warehouse management system: a case study. In 2018. p. 67.

- Manzoor, Q.-A. (2011) Impact of Employees Motivation on Organizational Effectiveness. Business Management and Strategy, 3 (1).
- Marczewski, A. (2013) Gamification: a simple introduction. Andrzej Marczewski.
- McKinnon, A.C., Browne, M., Piecyk, M., et al. (2015) Green logistics : improving the environmental sustainability of logistics. London : Kogan Page, 2015.
- Meister, J.C. (2013) How Deloitte Made Learning a Game. Available at: https://hbr.org/2013/01/how-deloitte-made-learning-a-g (Accessed: 02 July 2019).
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G. and Prisma Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, *6*(7), p.e1000097.
- Narayanan, A. (2014) Gamification for Employee Engagement. Birmingham, UK: Impackt Publishing.
- Newcomer, K.E., Hatry, H.P. and Wholey, J.S., 2015. Conducting semi-structured interviews. Handbook of practical program evaluation, 492.
- Papastergiou, M. (2009) Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. Computers & Education, 52 (1): 1–12.
- Putz, L.M., Hofbauer, F. and Mates, M., 2019. A vignette study among order pickers about the acceptance of gamification. In GamiFIN (pp. 154-166).
- Remi-Omosowon, A., Cant, R. and Langensiepen, C., 2016, April. Applying Gamification Principles to a Container Loading System in a Warehouse Environment. In 2016 UKSim-AMSS 18th International Conference on Computer Modelling and Simulation (UKSim) (pp. 79-84). IEEE.
- Richards, G. (2011) Warehouse management : a complete guide to improving efficiency and minimizing costs in the modern warehouse. London ; Philadelphia : Kogan Page, 2011.
- Ries, J.M., Grosse, E.H. and Fichtinger, J. (2017) Environmental impact of warehousing: a scenario analysis for the United States. International Journal of Production Research, 55 (21): 6485–6499.
- Robson, K., Plangger, K., Kietzmann, J.H., et al. (2015) Is it all a game? Understanding the principles of gamification. Business Horizons, 58 (4): 411–420.
- Robson, K., Plangger, K., Kietzmann, J.H., et al. (2016) Game on: Engaging customers and employees through gamification. Business Horizons, 59 (1): 29–36.
- Roodbergen, K.J. (2001) Layout and routing methods for warehouses. Rotterdam: Selbstverl.
- Schnorbach, P., 2015. BRINGING GAMIFICATION TO THE WAREHOUSE, Manhattan Associates [Available at: https://www.manh.com/resources/articles/2015/04/27/bringing-gamification-warehouse, Accessed: 2019-07-27]
- Smith, R., Bean, D. and Moeur, R. (2015) On the Integration of Human Computation into Traditional Business Processes., p. 4.
- Tella, A., Ayeni, C.O. and Popoola, S.O. (2007) Work Motivation, Job Satisfaction, and Organisational Commitment of Library Personnel in Academic and Research Libraries in Oyo State, Nigeria., p. 17.
- Teras, M., Reiners, T., Coldham, G. and Wood, L.C., 2016, May. nDiVE: Gamified virtual reality environment for Logistics and Supply Chain Management training. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (pp. 738-744).
- Tompkins, J.A., White, J.A., Bozer, Y.A., et al. (2010) Facilities planning. John Wiley & Sons.
- Van Den Berg, J.P. (2012) Highly competitive warehouse management : an action plan for best-in-class performance. Buren, The Netherlands : Management Outlook Publications, ©2012.
- Vrysagotis, V. and Kontis, P.A. (2011) Warehouse layout problems : Types of problems and solution algorithms., p. 22.
- Warmelink, H., Koivisto, J., Mayer, I., Vesa, M. and Hamari, J., 2020. Gamification of production and logistics operations: Status quo and future directions. Journal of Business Research, 106, pp.331-340.
- Warnlof, R. (2014) Guest Post: Bluewolf Goes Social - 4 Keys to Gamification Success. Available at: https://www.bunchball.com/blog/post/1559/guest-post-bluewolf-goes-social-4-keys-gamification-success (Accessed: 07 June 2019).
- Werbach, K. and Hunter, D. (2015) The gamification toolkit: dynamics, mechanics, and components for the win. Wharton Digital Press.
- Zichermann, G. and Cunningham, C. (2011) Gamification by design: Implementing game mechanics in web and mobile apps. O'Reilly Media, Inc.
- Zupan, H., Debevec, M. and Herakovic, N., 2017. Inventories In The Warehouse-Monitoring, Analyses And Optimization With Simulation. Acta Technica Corvininesis-Bulletin Of Engineering, 10(2).