Eliciting Requirements of a Knowledge Management System for Gaming in an Organization: The Role of Tacit Knowledge

Roungas, V.; Lo, J.C.; Angeletti, R.; Meijer, S.A.; Verbraeck, A.

DOI
10.1007/978-981-13-8039-6_32

Publication date
2019

Document Version
Final published version

Published in
Neo-Simulation and Gaming Toward Active Learning

Eliciting Requirements of a Knowledge Management System for Gaming in an Organization: The Role of Tacit Knowledge

Bill Roungas, Julia C. Lo, Rachele Angeletti, Sebastiaan Meijer, and Alexander Verbraeck

Abstract Games used by organizations generate a wealth of valuable output in terms of knowledge. In order to maintain the produced knowledge, such as the explicit, e.g., logging and questionnaires, and implicit/tacit knowledge, e.g., experience from game sessions, a knowledge management system (KMS) should be employed. This paper starts by giving a brief description of the building blocks for a KMS and then proposes a methodology that combines three different methods, namely, semi-structured interviews, causal maps, and the Q-methodology, to illustrate how tacit knowledge from principal stakeholders (game designers and project team members) can be extracted as part of building a KMS. The proposed methodology is applied in a case study related to the railway sector.

Keywords Knowledge management system · Game requirements · Tacit knowledge

B. Roungas (✉) · R. Angeletti · A. Verbraeck
Delft University of Technology, Delft, The Netherlands
e-mail: v.roungas@tudelft.nl; a.verbraeck@tudelft.nl

J. C. Lo
Delft University of Technology, Delft, The Netherlands

ProRail, Utrecht, The Netherlands
e-mail: j.c.lo@tudelft.nl

S. Meijer
Delft University of Technology, Delft, The Netherlands

KTH Royal Institute of Technology, Huddinge, Sweden
e-mail: sebastiaan.meijer@sth.kth.se

R. Hamada et al. (eds.), *Neo-Simulation and Gaming Toward Active Learning*, Translational Systems Sciences 18,
https://doi.org/10.1007/978-981-13-8039-6_32

1 Introduction

Gaming simulations (hereinafter referred to as games) used for decision-making have developed into a powerful tool for corporations [1]. Irrespective of their size, corporations have been increasingly using games in order to evaluate and ascertain impactful business decisions and strategies. Despite their proven added value to the decision-making process, there is still a lack of research on whether, and if so how, games can be used by researchers and practitioners to build evident on systems' behavior, as part of a larger scheme [1], in other words, whether and how knowledge acquired through games can be managed and reused and particularly how can implicit, also known as tacit, knowledge can be elicited, managed, and disseminated within an organization.

The management of both explicit and implicit knowledge from games is not, and should not be, of academic interest only. The effectiveness of a corporation depends heavily on how it manages this knowledge [2] or, in layman terms, how in the first place it obtains and thereafter maintains the so-called know-how. As a corporation acquires and builds up on knowledge obtained through games, it improves its know-how and thus sustains or even increases its competitive advantage [3].

The authors aim to propose a knowledge management framework (KMF) and subsequently build a knowledge management system [4] (KMS) for games. In this paper, the part of the framework pertaining particularly to the elicitation and reuse of tacit knowledge is analyzed. The specific selection of tacit knowledge for further analysis in this paper is due to the fact that tacit knowledge is an integral part of the decision-making processes of organizations yet one that has hardly been explicitly operationalized [5].

In Sect. 2, a brief description of the complete KMF is given as for the reader to see the bigger picture and the role of tacit knowledge within this picture. In Sect. 3, a methodology to capture and disseminate tacit knowledge within an organization is proposed. In Sect. 4, preliminary results from three case studies are illustrated. Finally, in Sect. 5, the future steps of this research are identified, and final remarks are made.

2 Knowledge Management in Games: The Building Blocks

With regard to knowledge, a distinction should be made about explicit and implicit, or tacit, knowledge. Explicit knowledge can be seen as academic, technical data, or information that is communicated in a formal language and/or shared digitally or in print, such as manuals [6]. On the other hand, tacit knowledge is cognitive or technical and consists of mental models, beliefs, insights, and perceptions. An example of an application of technical tacit knowledge is conducting train traffic operations [6].

Games generate a wealth of output depending on their application [7]. Games can be focused on training, design, research, and policy intervention, to name a few.

In Table 1, the different applications of games are shown based on two criteria: the type of knowledge generated by the game and the person or persons who are the beneficiaries of this knowledge. With regard to the type of knowledge generated, the authors distinguish between two categories: (1) generalizable, meaning that the knowledge acquired during the game provides for broad insights beyond the scope of a particular game scenario, and (2) contextual, meaning that the knowledge acquired during the game provides for deep insights closely related to a particular game scenario. With regard to the beneficiary of the generated knowledge, the authors again distinguish between two categories: (1) the participant, meaning that the beneficiary of the knowledge acquired during the game is the person or persons who play the game, and (2) the principal, meaning that the beneficiary of the knowledge acquired during the game is any stakeholder or stakeholders other than the participants, like decision-makers, researchers, or game designers.

The aim of this research as a whole is to build a complete KMF for games and particularly for games in engineering systems in which the knowledge type is contextual and the knowledge beneficiary is the principal. While this paper only focuses on the tacit knowledge produced by games, a brief description of the complete framework is deemed necessary for readers to understand the bigger picture and how tacit knowledge of involved stakeholders fits into the complete framework.

Regardless of the organization or the specific games they use, a KMF consists of some common building blocks that eventually contribute toward building a KMS. Namely, these blocks are:

- The type of the KMS. Currently there are two distinct types of KMS, *codification* and *personalization* [8]. *Codification* stores and makes available for reuse any acquired knowledge, which is in reality isolated from its source. On the other hand, *personalization* is the exchange of knowledge that has been acquired in the past through one-to-one conversations and brainstorming sessions; it is a way to promote discussion and exchange of ideas and knowledge between people in a more personal manner, and it is usually where most of the tacit knowledge is exchanged. The framework associated with this paper is a hybrid approach that combines *codification* and *personalization*, in order to harness the advantages of both methods and provide for a more formal way of capturing and reusing tacit knowledge.

Table 1 Canonical applications of gaming methods

	Knowledge beneficiary	
Knowledge type	Participant	Principal
Generalizable	Teaching	Research
	Experiential learning	Hypothesis generation and testing
	Dangerous tasks	Artifact assessment
Contextual	Policy	Design
	Organizational learning	Interactive visualization
	Policy intervention	Collaborative design

- The purpose of the KMS. A KMS can be used for one or more purposes, like root-cause analysis, own-project improvement, cross-project improvement, and network improvement. The proposed KMS will incorporate all these purposes, depending on the users.
- The intended users of the KMS. Any individual or group employed or even associated with the organization is a potential user of the KMS. In the proposed KMS, the potential users are individuals and groups related one way or another to games built or used by the organization.

3 Tacit Knowledge

In this section, first the different methods on how to capture tacit knowledge are examined, and then a comprehensive methodology that is used throughout the case studies is proposed.

3.1 State of the Art

One of the most common techniques for capturing tacit knowledge is "cognitive maps," which facilitate the representation of individuals' view of reality [9]. There are different types of cognitive maps, one of which is causal maps [10]. Causal maps are interpretations of individuals' or groups' beliefs about causal relationships [11]. Causal maps have been proven to be an effective tool for the elicitation of tacit knowledge for a variety or reasons, e.g., allowing to focus on action, eliciting context-dependent factors, etc. [10].

Semi-structured interviews are another tool that can help elicit tacit knowledge. While the purpose and structure of such an interview are predetermined, the essence of the "semi-structure" lies on the fact that interviewees are encouraged to answer questions by telling stories [10]. The storytelling nature of those kinds of interviews allows people to manage the collective memory of an organization [12], frame their experiences [13], and reflect on the complex social web of an organization [14].

Tacit knowledge encompasses a large amount of subjectivity and a research method to study its Q-methodology [15]. In a nutshell, in Q-methodology the interviewee sorts a series of items/statements throughout a continuum (e.g., from strongly disagree to strongly agree) that is approximately normally distributed, in the sense that more of these statements are placed close to the neutral area than in the two edges of the continuum.

Various scholars argue that the use of metaphors can serve to transmit tacit knowledge [10, 16], and since metaphors allow different ways of thinking, people may be able to explain complex organizational phenomena [17]. The term metaphors connotes the transfer of information from a relatively familiar domain to a relatively unknown domain [17].

Social media have become prominent on how people interact not only in a personal but also in a professional level. While research is still relatively poor in this area, the use of social media sounds indeed promising in tacit knowledge sharing, since they encompass interactive and collaborative technologies [18].

3.2 Methodology

The current study aims at capturing the tacit knowledge of principal stakeholders, mainly that of game designers, through a combination of semi-structured interviews, causal maps, and the Q-methodology. The interviews enable to capture knowledge (e.g., experiences, insights, etc.), and in turn causal maps are used to build the list of statements required by the Q-methodology. Then, using the Q-methodology, the interviewees sort these statements in accordance to their relevance.

In more detail, the interviews are partitioned in two sets. The first set of interviews is used to build the list of statements and subsequently the causal maps that are then used by the Q-methodology. For building a comprehensive list of statements for games, on average, the amount of interviews needed is between three and five. The second set of interviews actually uses the Q-methodology to sort the list of statements defined by the first set of interviews.

These three methods, i.e., interviews, causal maps, and Q-methodology, are stand-alone methods and thus could have been used on their own to approach the problem of eliciting tacit knowledge. Nevertheless, combining all three is expected to create a more robust methodology. The reasons that these particular methods were selected are the following:

Semi-structured interviews: Structured interviews have the risk of resulting in biased, on behalf of the interviewer, statements due to the lack of flexibility. Hence, providing a setup for the interviewees to expand on their answers, and not just answer closed or very structured questions, allows for more rich responses from which the statements for the Q-methodology are expected to be more descriptive.

Causal maps: The richness provided by the semi-structured interviews increases the risk for statements to overlap or to have strong causal relations (1 to 1, 1 to n, or n to 1). Hence, using causal maps enables the grouping of such statements and thus reducing, among other things, the effect of what in statistics is known as multicollinearity.

Q-methodology: Knowledge, and particularly tacit knowledge, is characterized not only by its subjectivity but also by its almost completely nonquantifiable nature. Therefore, using a methodology like Q seemed to be the most appropriate way forward with this research.

4 Case Studies

In this section, the methodology proposed in Sect. 3.2 is put into action. The full study includes three games that were conducted at ProRail. These games were selected based on a number of criteria, such as the technology used to build them (analog/digital), the degree to which they were considered to be successful, and the number of principal stakeholders involved. All games were multiplayer, varying from 3 to 23 participants.

The research is still ongoing, in which only the first game has been analyzed. For this game, called "OV-SAAL" [19], four interviews have been conducted, which have served as the first set for building the list of statements for the Q-methodology. OV-SAAL is an analog game, and its game design requirements are shown in Table 2.

The interviewees were principal stakeholders in the game with different roles: two game designers from academia and a game and an infrastructural designer from ProRail. Three out of four interviewees attended the main game session as observers. The interviews consisted of more than 20 questions, of which more than half aimed at understanding the game characteristics, the role of each stakeholder, and the input and output data. The last seven questions were concerned with the tacit knowledge produced in, and by, the game. These questions aimed at identifying the challenges each stakeholder faced, the lesson learned from the game, as well as whether and how they would do things differently if they were to repeat the game. Results from the initial interviews reveal a varying level of tacit knowledge by each of the principal stakeholders. For instance, each interviewee found certain challenges of the game session memorable, like the time pressure that was a consequence of the amount of conditions that were tested, the dynamics of the game in which the participants changed the game rules by adapting the speed of each round, and the extent to which the debriefing should be structured. Also, for the game designers from academia, the application of the game in a railway domain contributed to a better understanding of the train traffic operations. These four interviews resulted in building a list of 40 statements for the Q-methodology.

5 Conclusion and Future Work

In this paper, the building blocks for a KMF for games of engineering systems were first introduced. Then, the paper focused on the role of tacit knowledge and particularly on how to elicit this knowledge. In order to tackle the complex task of eliciting tacit knowledge, well-established methods from the literature were adopted and used in a case study involving three games from the railway sector. These methods included semi-structured interviews, causal maps, and the Q-methodology. The study is still ongoing, in which the first set of interviews has resulted in an extensive list of 40 statements required by the Q-methodology.

Table 2 Game design requirements of OV-SAAL game

Core aspects	Description
Purpose	Exploring the impact of different infrastructural expansions
Scenario	1. No infrastructural expansion
	2. Four additional tracks at Almere station
	3. Additional haul tracks at Weesp station
	4. Four additional tracks between Duivendrecht and Weesp station
	5. Implementation of European Rail Traffic Management System (ERTMS) in all four infrastructural layouts
Simulated world	Railway infrastructure on two trajectories: Amsterdam Central Station – Lelystad and Amsterdam Zuid – Hilversum, co-location of operators occurred by seating arrangements (each table was a control center). Current time table
No. of participants	8
Roles	Train traffic controller (TTC) (2), regional network controller (RNC) (2), national network controller (NNC) (1), regional passenger traffic monitor (RPTM) (2), national passenger traffic controller (NPTC) (1)
Type of role	Similar to own (5), prior experience in role (3)
Objectives	Determining own decisions for the next 15 min given the status of the system at paused moment
Constrains	Separation of train traffic regions: one regional train (2) and passenger traffic center (2) each versus other remaining regional train traffic center (2), exclusion of roles outside the defined infrastructure area, exclusion of train driver
Load	Four types of disruptions:
	1. Local train delay (+5 min)
	2. Freight train delay (+10 min)
	3. Corridor train (intercity) delay (+10 min)
	4. Disruption as chosen by participants themselves
Situation (external factors)	Presence of observers and video cameras. At the end of the day results were discussed with invited stakeholders
Time model	Step-wise (per time periods of 15 min)

With regard to future work, the list of 40 statements will be grouped using causal maps and then used in the remaining 15 interviews as part of the Q-methodology. That would result in obtaining an overview of the tacit knowledge possessed by the principal stakeholders, which in turn will be the cornerstone for building a KMS for games. Two additional case studies will be conducted to strengthen the generalizability of the KMS. The end goal of this research is to build a complete KMS combining explicit and tacit knowledge under one roof.

Acknowledgments This research is funded through the Railway Gaming Suite 2 program, a joint project by ProRail and Delft University of Technology.

References

1. Stephenson W (1953) The study of behavior: Q-technique and its methodology. The University of Chicago Press, Chicago
2. Boje DM (1991) Consulting and change in the storytelling organisation. J Organ Chang Manag 4(1):7–17
3. Smith EA (2001) The role of tacit and explicit knowledge in the workplace. J Knowl Manag 5(4):311–321
4. Roungas B, Meijer S, Verbraeck A (2018) Knowledge management of games for decision making. In: Simulation gaming. Applications for sustainable cities and smart infrastructures. ISAGA 2017, Lecture notes in computer science, vol 10825. Springer, Cham
5. Dixon NM (2000) Common knowledge: how companies thrive by sharing what they know. Harvard Business School Press, Boston
6. Martin J (1982) Stories and scripts in organizational settings. In: Hastorf AH, Isen AM (eds) Cognitive social psychology. Elsevier, New York, pp 255–305
7. Hansen MT, Nohria N, Tierney T (1999) What's your strategy for managing knowledge? In: Woods JA, James C (eds) The knowledge management yearbook 2000–2001. Butterworth-Heinemann, Boston, pp 1–10
8. Eden C, Jones S, Sims D, Smithin T (1981) The intersubjectivity of issues and issues of intersubjectivity. J Manag Stud 18(1):37–47
9. Grogan PT, Meijer SA (2017) Gaming methods in engineering systems research. Syst Eng 20(6):542–552
10. Markus LM (2001) Toward a theory of knowledge reuse: types of knowledge reuse situations and factors in reuse success. J Manag Inf Syst 18(1):57–93
11. Markíczy L, Goldberg J (1995) A method for eliciting and comparing causal maps. J Manag 21(2):305–333
12. Alavi M, Leidner DE, Alavi John M (2001) Knowledge management and knowledge management systems: conceptual foundations and research issues. MIS Q 25(1):107–136
13. Lo JC, Meijer SA Participatory design in large-scale railway infrastructure using gaming simulations: the role of shared mental models. Under Review
14. Brockmann EN, Anthony W (1998) The influence of tacit knowledge and collective mind on strategic planning. J Manag Issues 10(2):204–222
15. Tsoukas H (1991) The missing link: a transformational view of metaphors in organizational science. Acad Manag Rev 16(3):566–585
16. Wilkins AL, Thompson MP (1991) On getting the story crooked (and straight). J Organ Chang Manag 4(3):18–26
17. Panahi S, Watson J, Partridge H (2012) Social media and tacit knowledge sharing: developing a conceptual model. In: World Academy of Science, Engineering and Technology (WASET). WASET, Paris, pp 1095–1102
18. Brown JS, Duguid P (1991) Organizational learning and communities-of-practice: toward a unified view of working, learning, and innovation. Organ Sci 2(1):40–57
19. Ambrosini V, Bowman C (2001) Tacit knowledge: some suggestions for operationalization. J Manag Stud 38(6):811–829