Chapter 24
Can Hard Paradigm Artefacts Support Soft Paradigm Imperatives? An Unpaired Comparative Experiment to Determine whether Visualisation of Data Is an Effective Collaboration and Communication Tool in Project Problem-Solving

Alison Davies and John Heathcote

24.1 Introduction

Project management is now prevalent across all sectors (Maylor, Brady, Cooke-Davies, & Hodgson, 2006; Pellegrinelli, 2011) and has developed beyond product delivery to encompass organisational change, the transformation of businesses and the implementation of strategies (Winter, Smith, Morris, & Cicmil, 2006, p. 638). This "projectification" (Midler, 1995, quoted in Maylor et al., 2006, p. 663) has resulted in organisations adopting numerous PM practices and techniques to deliver change (Maylor, 2010). Nevertheless, despite decades of PM tools, approaches and processes, projects continue to fail (Morris, 2013; Pinto, 2013). Svejvig and Andersen (2015) suggest that classical PM methodologies based upon a hard, deterministic paradigm of certainty and rational decision-making have "remained fairly static in the past" (Koskela & Howell, 2002, cited in Svejvig & Andersen, 2015, p. 278) and have proven inadequate in practice (Cicmil, Williams, Thomas, & Hodgson, 2006). This includes the failure to recognise and focus upon the front-end work to ensure problems are fully identified (Morris, 2013; Pinto & Winch, 2016) and effective decision-making takes place to identify optimum solutions (Shore, 2008; Samset & Volden, 2016), ensuring projects are delivered successfully and benefits realised. Indeed, Samset and Volden (2016, p. 301) add that "agreeing on the most effective solution to a problem and choice of concept need to be dealt with

A. Davies (✉) · J. Heathcote
School of the Built Environment and Engineering, Leeds Beckett University, Leeds, UK
e-mail: j.heathcote@leedsbeckett.ac.uk

C. Gorse et al. (eds.), *Climate Emergency – Managing, Building, and Delivering the Sustainable Development Goals*, https://doi.org/10.1007/978-3-030-79450-7_24

as early as possible" as this work at the front-end phase is crucial to project success. Stingl and Geraldi (2017, p. 121) purport that decision-making is "integral to the management of projects", which is supported by Pollack and Adler's (2015, p. 247) research into keyword analysis of 95,000 unique records that revealed, "issues associated with decision making are central to PM research". Research has also consistently identified effective communication as a key factor to project success (Rezvani et al., 2016), and therefore team working and the identification of problems and agreement of solutions are essential; nevertheless effective team working is difficult to achieve (Stingl & Geraldi, 2017). However, behavioural economic theory states that human decision-making is flawed and prone to make the same mistakes repeatedly, such as loss aversion and availability error (Kahneman, 2012; Sutherland, 2013), and "actual decision behaviour deviates strongly from the rational ideal" (Stingl & Geraldi, 2017, p. 121); therefore this poses a key challenge to project success.

Consequently there is a need to consider new ways of thinking about the PM discipline, and Pollack (2007) suggests a soft paradigm is required that focuses upon facilitation, participation and effective communication with stakeholders to address these contemporary issues; it seems the "primary problems of project managers are not technical, but human" (Posner, 1987, quoted in Pollack, 2007, p.270). It appears that project managers are applying "practices that circumvent some of the problems encountered in the classical approach" (Svejvig & Andersen, 2015, p. 286). Hällgren and Sőderholm's (2011) research demonstrates that project plans can be used in the hard paradigm model for tracking progress but also can be utilised to enhance understanding and communication within the soft paradigm. Therefore, one approach to tackle the complex nature of decision-making in projects is to summarise the data into infographics. This visual representation of data in a graphic format can enhance understanding and communication as it allows for rapid summarising of data (Bititci, Cocca, & Ates, 2016) to identify themes and issues and can aid effective decision-making through the identification of possible problem and solutions. As a result, this research explores the use of the visualisation of data to address the problem of flawed decision-making, problem-solving and social processes within projects.

24.2 Project Management: Hard and Soft Paradigms

Growing theoretical disquiet (Pollack, 2007) among researchers and criticism of classical PM (Svejvig & Andersen, 2015) by senior practitioners have seen an emergence of a RPM initiative, which identifies five directions for further research to address these concerns and to "connect it more closely to challenges of contemporary project management practice" (Winter et al., 2006, p. 639). The initiative calls for new approaches in "project complexity, social process, value creation, project conceptualisation, and practitioner development" (Winter et al., 2006); this research draws upon the first four directions, in particular. The project complexity direction suggests that a new way of thinking about projects is required, which is currently based upon a dominant literature (Padalkar & Gopinath, 2016) that is predicated upon a deterministic paradigm or "hard systems model" (Winter et al., 2006, p. 640), which centres upon control and certainty. However, RPM does not dismiss the hard paradigm of tools and techniques but suggests a need for considering project conceptualisation in a new light, which encompasses a soft paradigm, focusing upon "people and participation" (Pollack, 2007, p. 270). Indeed, people are fundamental to value creation, and the need to focus upon problem-solving at the front end of projects is now widely recognised (Matinheikki, Artto, Peltokorpi, & Rajala, 2016; Morris, 2013; Samset & Volden, 2016). RPM calls for new approaches and holistic thinking to "assist practitioners at the messy front end" (Winter et al., 2006, p. 645) through problem-solving methods that combine the soft and hard aspects of projects. However, projects are inherently complex, which makes objective decision-making difficult, but one solution could be the use of visualisation of data to facilitate improved group interaction, decision-making and problem-solving. Eppler and Platts (2009) identify three main types of benefits for visual representation: cognitive, social and emotional, which would support the issues identified. Data represented visually would help a project group develop a common view of the information quickly, which would assist them in decision-making in a variety of ways including the identification of constraints, problems and possible solutions. It could be argued that visual representations are already used extensively in projects, such as Gantt charts, but they are used in a standardised format to track project progress and PM literature does not take into account these additional fields of study within practice to aid project success. As a result this research aims to contribute to RPM by exploring the concept that PM should focus on the human decision-making aspect to solve problems and consider whether the use of visual tools helps groups work more effectively together, facilitating better interaction, thus further developing practical application of PM. It may also advance project conceptualisation by examining whether hard paradigm artefacts can support soft paradigm imperatives and establish a conceptual link to replace this paradigmatic separation.

24.3 Visualisation and Cognitive Fit Theory

Visualisation of data is defined as the "collection, transformation and presentation of qualitative and quantitative data" (Al-Kassab, Ouertani, Schiuma, & Neely, 2014, p. 3), in a variety of visual formats including graphs, tables, bar charts, diagrams and infographics. According to Moore (2017), standalone data does not contribute to sense making, but when data is combined in a meaningful way, it generates knowledge that can assist decision-makers in problem-solving. As such visualisation of data in "a methodically developed graphic" (Moore, 2017, p. 130) presents an opportunity for decision-makers to gain "insights, develop understanding, identify patterns, trends or anomalies faster, and promote engaging discussions"

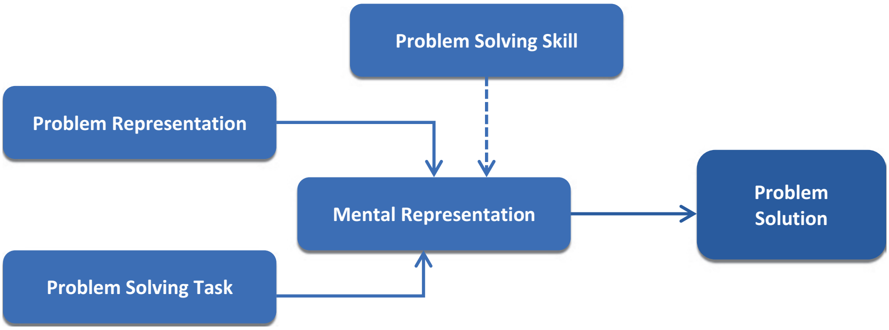

Fig. 24.1 Cognitive fit theory: problem-solving model (Vessey & Galletta, 1991)

(Dasgupta et al., 2015, quoted in Moore, 2017, p. 130). It is a useful tool to present complex information and thus enable more effective group interaction (Moore, 2017).

Vessey and Galletta's (1991) experimental study into the effectiveness of graphs versus tables in problem-solving resulted in development of cognitive fit theory, which draws upon consumer behaviour and behavioural decision theory. Cognitive fit theory (Fig. 24.1), which is the dominant theory within visualisation literature (Engin & Vetschera, 2017; Kopp, Riekert, & Utz, 2018; Teets, Tegarden, & Russell, 2010), suggests that "for the most effective and efficient problem solving to occur, the problem representation and any tools or aids employed should all support the strategies, methods or processes, required to perform the task" (Vessey & Galletta, 1991, p. 64).

According to Vessey and Galletta (1991), if the problem representation (visual data) fits the problem-solving task appropriately, then the problem-solver is able to formulate a mental representation of the problem, which will ultimately generate solutions quicker and more accurately (Teets et al., 2010). If, however, there is a mismatch between the problem representation and task, then cognitive fit will not occur, and the problem-solver will have to transform either the task or representation to allow for problem-solving (Vessey & Galletta, 1991).

Research identified that graphs are "spatial problem representations", which "emphasize information about relationships in the data" (Vessey & Galletta, 1991, p. 67), and tables are "symbolic problem representations, which emphasize information on discrete data values" (Vessey & Galletta, 1991, p. 67). Subsequent research has determined that the choice of visual representation significantly affects decision-making, and selecting the appropriate visual can therefore enhance problem-solving performance, for example, a spatial task would be best supported by graphical information (Moore, 2017; Teets et al., 2010).

In addition, cognitive load also plays an important role within cognitive fit theory and effective decision-making (Phillips, Prybutok, & Peak, 2014). Cognitive load is defined as the "mental effort on the part of the decision-maker" (Phillips et al., 2014, p. 375). If there is a mismatch between task and representation, then problem-solving becomes more difficult as the cognitive load becomes greater. The problem-solver needs to “expend more mental effort” (Phillips et al., 2014, p. 379), which results in the “resource consuming and effortful System 2 being replaced by heuristic methods of System 1” (Engin & Vetschera, 2017, p.96), thus reducing performance. The relevance of the visual representation is therefore important to reduce cognitive load, so that “cognitive resources remain available for deeply processing and understanding the given material” (Kopp et al., 2018, p. 369).

Literature has highlighted a number of benefits in using visualisation of data including “cognitive, social and emotional” (Eppler & Platts, 2009). Visual data improves “synthesis of information” (Bititci et al., 2016, p. 1573) and facilitates pattern recognition and problem-solving. It also allows disparate groups to come together to gain a mutual understanding of issues, and from an emotional perspective, it “creates involvement and engagement, providing inspiration and convincing communication” (Bititci et al., 2016, p. 1573).

The benefits of visualisation as a decision-making tool have already been discussed and are incorporated within Eppler and Platts’s (2009) cognitive benefits. Visualisation as a means of knowledge management aids the transfer, sharing and creation of knowledge (Al-Kassab et al., 2014) by “operating as a catalyst for interpretations” (Al-Kassab et al., 2014, p. 6). It could be argued that this function is linked to Eppler and Platt’s social benefit as it enhances shared learning. However, care is needed to avoid misrepresentation of data (Bititci et al., 2016) that may focus attention on partial information, thus distorting knowledge (Al-Kassab et al., 2014). Indeed Bresciani and Eppler (2015, p. 1) identified a number of “pitfalls of visual representations” and call for further research. The selection of an appropriate image or visual can ensure complex information is readily comprehensible (Al-Kassab et al., 2014) and is therefore an effective communication medium. Visualisation improves communication and acts as a “collaboration catalyst” (Eppler & Bresciani, 2013, p. 146), and it seems these two elements are intrinsically linked. The suitability and fit of visual data used in this research are discussed in the Methodology section below. It appears that visualisation of data is an effective tool to aid decision-making and problem-solving in projects; however, there is limited literature in this area within the field of PM. Research tends to focus upon 3D visualisation (Jaber, Sharif, & Liu, 2016) often within the construction industry or on strategic decision-making (Killen, 2013; Killen & Kjaer, 2012) in a project portfolio setting. This research therefore contributes to a gap in the PM discipline, particularly relating to the use of visual data to enhance group collaboration and communication to improve problem-solving and decision-making.

24.4 Research Review and Methodology

There is a wealth of literature about the multi-disciplinary nature of PM and analysis of research trends and themes (Kwak & Anbari, 2009; Padalkar & Gopinath, 2016; Pollack & Adler, 2015). Smyth and Morris’ (2007, p. 433) epistemological evaluation of project research criticised the “lack of epistemological care taken in the selection and application of research methodologies", particularly relating to a positivist methodology and, for example, the use of contradictory case study approaches. Positivist epistemology explores human and social behaviour (Easterby-Smith, Thorpe, & Jackson, 2015), and this is "typically marked by an experimental design" (Stingl & Geraldi, 2017, p. 124). Stingl and Geraldi (2017) identified three schools of thought regarding behavioural decision-making in projects, and this research draws upon the reductionist school, which assumes decision-makers are cognitively limited (Lovallo & Kahneman, 2003). The methodology builds upon "the experimental approach of psychology and cognitive sciences" (Stingl & Geraldi, 2017, p. 124), and it is rooted in a positivist epistemology. As a result, an unpaired experimental design, with an independent variable (visualisation of data), will be conducted, which is expected to improve the dependent variable (improved collaboration and communication). Analysis of this empirical data will test the hypotheses defined below.

Research question: Does the visualisation of data facilitate improved group interaction?

Research Hypotheses.

H_0 (null hypothesis):	There is no statistically significant relationship between the use of visual data and the facilitation of better interaction in a project group.
H_1 (alternative hypothesis):	There is a statistically significant relationship between the use of visual data and the facilitation of better interaction in a project group.

24.5 Research Method

This study is based upon a postpositivist epistemology that tests whether visualisation of data can improve group communication and collaboration. Similarly, Killen's (2013, p. 804) research explored use of visualisation of data to "support project portfolio decision making" and utilised a controlled experiment with a control group that only had tabular information and two other intervention groups, with differing visual data to determine whether data types impact upon decision-making. Experimental designs are generally conducted within the fields of psychology and economics and, as such, are not a method that is often used in PM (Killen, 2013), providing valuable experience within the discipline (Killen, 2013).

Research was conducted in a Hydra Suite laboratory, which is a laboratory-style facility, designed to create "critical decision immersive simulations" (Leeds Beckett, n.d.). Participants undertook a simulated problem-solving task so that the number of identified problems and solutions was recorded and therefore could be measured. The Hydra Suite laboratory allows for a controlled environment and removes multiple variables so that the focal variable (visual representation) can be tested. This comparative, true experiment (Robson, 2011) will test the difference between treatment conditions, that is control (no treatment) and intervention groups (experiential treatment). The control group was presented with a typical business case, which is in text format, and asked to identify problems and possible improvements to the organisation; the intervention group was provided with the same information, but the independent variable was a visual representation of data. It is predicted that the visual data will enhance collaboration, communication and problem-solving, and the number of outputs will be recorded and measured. In addition, the Hydra Suite laboratory has video recording capabilities so that observation of group interaction also took place.

Research has shown that charts and graphs reduce information overload (Kopp et al., 2018). To allow for participants' cognitive style, which is a preference for how information is processed, a number of visual images were used; this ensures cognitive load is not increased (Engin & Vetschera, 2017). The visual data included a Gantt chart depicting a standard manufacturing process, which also included a bar chart displaying financial information. Leach (2010, cited in Jaber et al., 2016) suggests Gantt charts should be over-layered with budget information to provide a comprehensive overview of business processes. A separate infographic, which represents information from these other two visuals, was also provided. Details of the experiment and outlining how the data was collected are shown below.

Upon arrival at the Hydra Suite laboratory, all participants received a short briefing session about the experiment and randomly assigned to either control or intervention groups; each group was assigned to a separate Hydra laboratory syndicate room to participate in the activity. Each room contained a briefing document, which provided instructions to the participants, for the 20-min group activity: view the documents provided in the room relating to the business case; identify problems with existing processes and possible options/solutions; and assign one person the task of writing the group's ideas on the paper provided. The control group was provided with a text format only, which provided information about a typical manufacturing company. The intervention group was also provided with an independent variable, that is, the visual data. The researcher observed and recorded each group in the Hydra laboratory control room, and an example of an intervention group activity is shown in Figs. 24.2, 24.3, and 24.4.

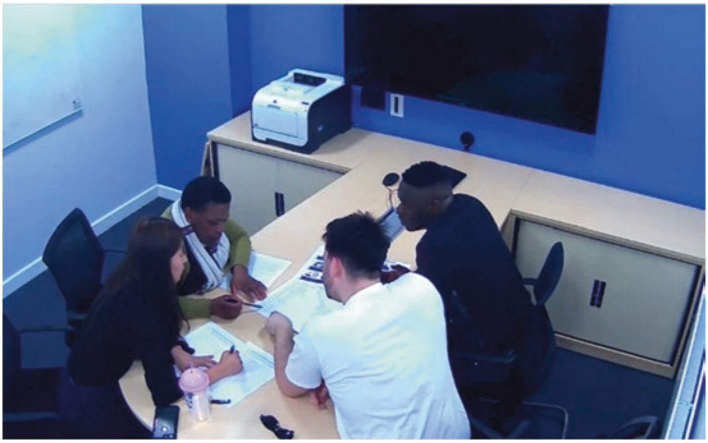

Fig. 24.2 Video snapshot of experiment – intervention group

Fig. 24.3 Intervention group interaction with visual documents

Fig. 24.4 Control group: individual focus on text only documents

24.6 Research Results

Observationally (Fig. 24.2) interaction was evident, facilitated by the pictorial schematics and Gantts. The Hydra Suite laboratory allowed for a recorded observation.

Observationally (Fig. 24.3) interaction was evident, facilitated by the pictorial schematics and Gantts.

Whereas the control groups initially worked through the text only documents individually (Fig. 24.4) and this delayed communication and collaboration to identify problems.

Overall participants in the intervention groups identified the first problem more quickly, which seems to suggest visual representation of data aids decision-making through easier identification of patterns and problems.

Interestingly, one participant in a control group drew a visualisation of the data to help synthesise the information, particularly relating to procurement, which she had identified as an issue. She explained to the group, "It's difficult to think about processes and how they overlap.um. connect. I'm going to jump in and draw a little something for the procurement so I can see…so I can get my head around it". This is important as it suggests the visual aid eased cognitive load and enabled the participants to make sense of the information. As a result, the controlled environment became flawed, as a visual diagram was introduced, and therefore the outputs of this group were reclassified as an intervention group.

Figure 24.5 shows the number of problems and solutions following the redistribution of data, and again the box and whisker plots show a visual difference between the intervention groups (1) and control groups (2).

In this instance an outlier was introduced in the number of problems identified, which skewed the results. Overall, however, findings show that there is a visual difference between the independent variable introduced to the intervention group, within the box and whisker plots. Nevertheless, the probability of results being due

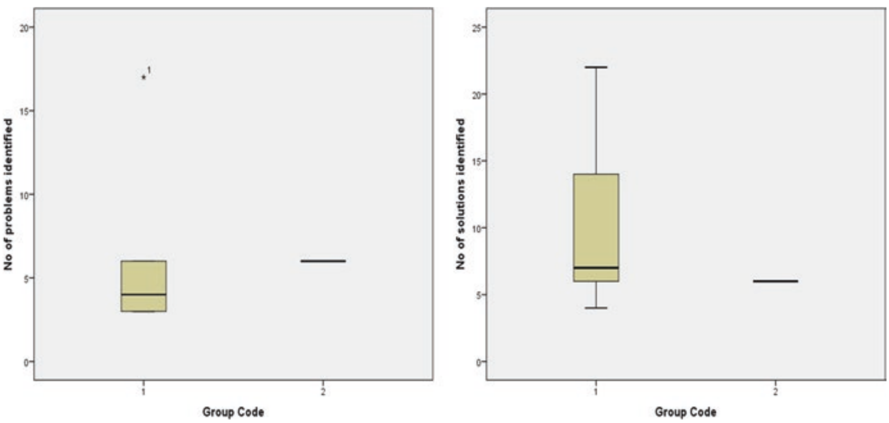

Fig. 24.5 No of problems and solutions identified

to chance remains high. There is concern that behavioural economic experiments "are too often, too easily generalised and interpreted as general human attributes" (Berg, 2014,p. 228), and this is mirrored by Kahneman who admits that it is not "uncommon among psychologists to overestimate the reliability and validity of results based on small samples" (Kahneman, 2011, quoted in Berg, 2014, p. 228). The experiment set out to test whether the visualisation of data improved group interaction, but this research acknowledges on this occasion the number of iterations of the experiment (*N*- = 7) resulted in insufficient data to arrive at statistical significance and therefore the null hypothesis (H_0) could not be accepted or rejected. Although not conclusive, the additional observational notes do appear to support the alternative hypothesis (H_1). It appears likely that statistical significance could be achieved as the experiment is based on sound methodology if additional iterations were conducted.

24.7 Conclusion

This study tackles a theoretical and contemporary challenge in practice that focuses upon flawed decision-making in projects. Firstly, this study confirmed that cognitive biases and two systems thinking identified and developed within behavioural economic theory affect project success. This is due to a number of biases that hamper effective decision-making which provide an illusion of control and overconfidence in problem-solving, with a predetermined or first solution often being selected for project development. This research has focused upon the reductionist school of behavioural decision-making, which identifies these as predictable and deep-rooted errors. The dominant, hard, deterministic PM paradigm has remained fairly fixed and inadequate in practice, but a change in approach is needed, to address this decision-making issue, as projects become increasingly complex.

Secondly, the study revealed that visualisation of data could offer such a new approach to improved problem-solving, particularly at the front-end problem formulation stage as it transforms complex data into an understandable format. It is dependent upon cognitive fit theory and the need to reduce cognitive load so that the visual data is matched to the problem-solving task. When this occurs, visualisation of data enhances understanding and forges a mutual understanding of the information and shared knowledge, thus improving interaction and decision-making.

Thirdly, there was anticipation that the experimental analysis would reject the (H_0) null hypothesis and support the (H_1) alternative hypothesis to demonstrate that visualisation of data improves group interaction. Unfortunately, however, the study was underpowered and lacked statistical significance; therefore the $H_{0\,(}$null hypotheses) could not be accepted or rejected. Nevertheless, the box and whisker plots showed a visual difference in favour of the intervention groups, and observations highlighted that there was better collaboration and communication, together with quicker problem identification in the intervention groups. Arguably, further iterations could produce statistical significance, as the research methodology is sound and repeatable.

Finally, this research has determined that projects and project success are about people. People have to manage project complexity and uncertainty and undertake effective problem-solving processes at the neglected front end of projects to ensure they choose the right concept, and this is delivered effectively. Problem-solving and decision-making are intrinsically linked, but fundamentally human behavioural decision-making is flawed, which impacts directly upon project success. Armed with this knowledge, project environments can be changed, and a new holistic approach adopted to minimise these biases. Visualisation of data is used as a project management tool under the traditional dominant hard deterministic paradigm, but there is an opportunity to adopt new perspectives and use visual data to generate knowledge, effective communication and a mutual understanding of problems to aid quality decision-making. Effectively this would bring the two project management paradigms together and in response to Pinto (2013) would stop making our lives more difficult than necessary.

24.8 Limitations

The main weakness and limitation of this study are the number of participants recruited was an insufficient sample size to achieve statistical significance and therefore the (H_0) null hypothesis could not be accepted or rejected. Therefore, results could not be generalised to the population.

References

Al-Kassab, J., Ouertani, Z., Schiuma, G. & Neely, A. (2014) Information visualization to support management decisions. International Journal of Information Technology & Decision-making [Online], 13, (2), pp. 407–428. Retrieved August 4, 2018, from http://www.ebsco.host.com.

Berg, L. (2014) Who benefits from behavioural economics? Economic Analysis and Policy [Online], 44, pp.221–232. Retrieved August 4, 2018, from http://www.ebsco.host.com.

Bititci, U., Cocca, P. & Ates, A. (2016) Impact of visual performance management systems on the performance management practices of organisations. International Journal of Production Research, 54 (6), pp.1571–1593. Retrieved April 4, 2018, from http://www.ebsco.host.com.

Bresciani, S. & Eppler, M. (2015) The pitfalls of visual representations: A review and classification of common errors made while designing and interpreting visualizations. Sage Open [online], 5 (4), pp.1-14. Retrieved July 24, 2018, from http://www.ebsco.host.com.

Cicmil, S., Williams, T., Thomas, J., & Hodgson, D. (2006). Rethinking project management: Researching the actuality of projects. *International Journal of Project Management, 24*, 675–686.

Dasgupta, A., Poco, J., Wei, Y., Cook, R., Bertini, E., & Silva, C. (2015). Bridging theory with practice: An exploratory study of visualization use and design for climate model comparison. *IEEE Transactions on Visualization and Computer Graphics, 21*(9), 996–1014. Quoted in: Moore, J. (2017) Data visualization in support of executive decision-making. Interdisciplinary

Journal of Information, Knowledge & Management [Online], 12, pp.125–138. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Easterby-Smith, M., Thorpe, R., & Jackson, P. (2015). *Management and business research* (5th ed.). London: Sage.

Engin, A. & Vetschera, R. (2017) Information representation in decision-making: The impact of cognitive style and depletion effects. Decision Support Systems, 103, pp.94-103. Retrieved July 29, 2018, from http://ebscohost.com.

Eppler, M. & Bresciani, S. (2013) Visualization in management: From communication to collaboration: A response to Zhang. Journal of Visual Languages and Computing [Online], 24 (2), pp.146–149. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Eppler, M. & Platts, K. (2009) Visual strategizing: The systematic use of visualization in the strategic planning process. Long Range Planning [Online], 42, pp.42–74. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Hällgren, M., & Sőderholm, A. (2011). Projects-as-practice—New approach, new insights. In P. Morris, J. Pinto, & J. Sőderland (Eds.), *The Oxford handbook of project management*. Oxford: Oxford University Press.

Jaber, K., Sharif, B. & Liu, C. (2016) An empirical study on the effect of 3D visualization for project tasks and resources. Journal of Systems and Software 115, pp.1-17. Retrieved July 29, 2018, from http://ebscohost.com.

Kahneman, D. (2011). *Thinking, fast and slow*. Allan Lane: Penguin Books. Quoted in: Berg, L. (2014) Who benefits from behavioural economics? Economic Analysis and Policy [Online], 44, pp.221–232. Retrieved August 4, 2018, from http://www.ebsco.host.com.

Kahneman, D. (2012). *Thinking, fast and slow*. London: Penguin Books.

Killen, C. (2013). Evaluation of project interdependency visualizations through decision scenario experimentation. *International Journal of Project Management, 31*, 804–816.

Killen, C., & Kjaer, C. (2012). Understanding project interdependencies: The role of visual representation, culture and process. *International Journal of Project Management, 30*, 554–566.

Kopp, T., Riekert, M. & Utz, S. (2018) When cognitive fit outweighs cognitive load: Redundant data labels in charts increase accuracy and speed of information extraction. Computers in Human Behaviour [Online], 86, pp.367–376. Retrieved August 10, 2018, from http://ebscohost.com.

Koskela, L. & Howell, G. (2002) The underlying theory of project management is obsolete. PMI Research Conference 2002, PMI, pp.293-302. Cited in: Svejvig, P. & Andersen, P. (2015) rethinking project management: A structured literature review with a critical look at the brave new world. International Journal of Project Management, 33, pp.278–290.

Kwak, Y., & Anbari, A. (2009). Analyzing project management research: Perspectives from top management journals. *International Journal of Project Management, 27*, 435–446.

Leach, K. (2010) *Project schedule visualization*. Retrieved October 26, 2016, from http://www.steelray.com. Cited in: Jaber, K., Sharif, B. & Liu, C. (2016) an empirical study on the effect of 3D visualization for project tasks and resources. Journal of systems and software, [online], 115, pp.1-17. Retrieved July 29, 2018, from http://ebscohost.com.

Leeds Beckett University (n.d.) Leeds Beckett University facilities [online], Leeds: Leeds Beckett University. Retrieved August 8, 2018, from http://www.leedsbeckett.ac.uk/leeds-business-school/facilities//.

Lovallo, D. & Kahneman, D. (2003) Delusions of success: How optimism undermines executives' decisions. Harvard Business Review [online], 81 (7) July, pp. 56-63. Retrieved November 29, 2018, from http://ebscohost.com.

Matinheikki, J., Artto, K., Peltokorpi, A., & Rajala, R. (2016). Managing inter-organizational networks for value creation in the front-end of projects. *International Journal of Project Management, 34*, 1226–1241.

Maylor, H. (2010). *Project management* (4th ed.). Harlow: Pearson Education Limited.

Maylor, H., Brady, T., Cooke-Davies, T., & Hodgson, D. (2006). From projectification to programmification. *International Journal of Project Management, 24*, 663–674.

Midler, C. (1995). Projectification of the firm: the Renault case. *Scandinavian Journal of Management, 11*(4), 363–375. Quoted in: Maylor, H. et al. (2006) From projectification to programmification. International Journal of Project Management, 24, pp.663–674.

Moore, J. (2017) Data visualization in support of executive decision-making. Interdisciplinary journal of information, Knowledge & Management [Online], 12, pp.125–138. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Morris, P. (2013) Reconstructing project management reprised: A knowledge perspective. Project Management Journal [Online], 44 (5), pp.6–23. Retrieved January 14, 2018, from http://www.ebsco.host.com.

Padalkar, M., & Gopinath, S. (2016). Six decades of project management research: Thematic trends and future opportunities. *International Journal of Project Management, 34*, 1305–1321.

Pellegrinelli, S. (2011). What's in a name: Project or programme? *International Journal of Project Management, 29*, 232–240.

Phillips, B., Prybutok, V. & Peak, D. (2014) Determinants of task performance in a visual decision-making process. Journal of Decision Systems [Online], 23 (4), pp.373–387. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Pinto, J. (2013) Lies, damned lies, and project plans: Recurring human errors that can ruin the project planning process. Business horizons [online], Business Horizons, 56, pp.643–653. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Pinto, J., & Winch, G. (2016). The unsettling of "settled science" – The past and future of the management of projects. *International Journal of Project Management, 34*, 237–245.

Pollack, J. (2007). The changing paradigms of project management. *International Journal of Project Management, 25*, 266–274.

Pollack, J., & Adler, D. (2015). Emergent trends and passing fads in project management research: A scientometric analysis of changes in the field. *International Journal of Project Management, 33*, 236–248.

Posner, B. (1987). What it takes to be a good project manager? *Project Management Journal, 18*(1), 51–54. Quoted in: Pollack, J. (2007) The changing paradigms of project management. International Journal of Project Management, 25, pp.266–274.

Rezvani, A., Chang, A., Wiewiora, A., Ashkanasy, N., Jordan, P., & Zolin, R. (2016). Manager emotional intelligence and project success: The mediating role of job satisfaction and trust. *International Journal of Project Management, 34*, 1112–1122.

Robson, C. (2011). Real world research (3rd ed.). Chichester: Wiley.

Samset, K., & Volden, G. (2016). Front-end definition of projects: Ten paradoxes and some reflections regarding project management and project governance. *International Journal of Project Management, 34*, 297–313.

Shore, M. (2008) Systematic biases and culture in project failures. Project Management Journal [Online], 39 (4), pp.5–16. Retrieved July 20, 2018, from http://www.ebsco.host.com.

Smyth, H., & Morris, P. (2007). An epistemological evaluation of research into projects and their management: Methodological issues. *International Journal of Project Management, 27*, 423–436.

Stingl, V., & Geraldi, J. (2017). Errors, lies and misunderstandings: Systematic review on behavioural decision making in projects. *International Journal of Project Management, 35*, 121–135.

Sutherland, S. (2013). *Irrationality: The enemy within*. London: Pinter & Martin.

Svejvig, P., & Andersen, P. (2015). Rethinking project management: A structured literature review with a critical look at the brave new world. *International Journal of Project Management, 33*, 278–290.

Teets, J., Tegarden, D. & Russell, R. (2010) Using cognitive fit theory to evaluate the effectiveness of information visualizations: An example using quality assurance data. IEEE Transactions on Visualization and Computer Graphics [Online], 16 (5), pp.841–853. Retrieved July 4, 2018, from http://www.ebsco.host.com.

Vessey, I., & Galletta, D. (1991). Cognitive fit: An empirical study of information acquisition. *Information Systems Research [online], 2*(1), 63–84. Retrieved July 20, 2018, from http://www.ebsco.host.com.

Winter, M., Smith, C., Morris, P., & Cicmil, S. (2006). Directions for future research in project management: The main findings of a UK government-funded research network. *International Journal of Project Management, 24*, 638–649.