Visualization of Environmental Performance Indicators (EPI) on Business Process Models: a hospitality industry perspective

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1 Research problem and motivation

Reducing the environmental impact of organizational operations is of major importance since governments and societies place great emphasis on the sustainable use of natural resources. Hence, environmental sustainability [ES] becomes a focus and a competitive advantage for organizations [1]. Such a focus, however, requires additional effort for organizations to manage operational efficiency and reduce environmental impact. The environmental impact is measured using core environmental performance indicators (EPIs) comprising water consumption, energy consumption, waste generation, recycling of materials, and CO2 and greenhouse gas (GHG) emissions [2]. Government and auditing companies use EPIs to audit the environmental performance of organizations. However, it is a challenge to identify, measure and monitor energy and water consumption as well as all other EPIs through the existing methods and beyond energy and water bills.

From a Business Process Management (BPM) perspective [3], managing business process performance requires the identification and measurement of performance indicators and a shared perception of how processes and their inputs and outputs contribute to the performance objectives of operations [4]. Likewise, managing the environmental impact of business processes depends on a clear identification, measurement and an effective visualization of EPIs. Thus, the research question of my thesis is how to identify, measure and visualize EPIs for business process models.

There are currently no empirically developed and validated approaches for identifying and visualizing EPIs on business process models. Recker [5] proposed environmental-risk awareness in BPM, followed by the suggestion to develop a modelling notation to reflect carbon footprints in business process models [6]. Other researchers [7, 8] have proposed frameworks for process-based measurement of energy consumption and suggested developing an activity-based reporting tool for GHG emissions; or have proposed [9] a method to measure energy consumption, CO_2 and other performance indicators of processes. However, the majority of these studies are conceptual and they do not provide empirical validation of the results. I am, therefore, motivated to pursue the development of an EPI process notation. Consequently, based on the original idea of context-aware process management [10] and risk-aware process management [11], I aim to design a solution for organizations, environmental auditors and decision-makers to enable them to identify, measure and visualize EPIs on business process models.

2 Intended Solution

I am developing a method to identify, measure and visualize EPIs on top of existing business process models by designing and evaluating two artefacts: a) a modelling notation to visualize EPIs on process models, which I refer to throughout this document as the “EPI process notation”, and b) a method to identify, measure and use the EPI as a process notation.

3 Background Literature

From a BPM standpoint, process modelling focuses on effective visualization of complex business and system processes to communicate the business activities and relevant resources and information with individuals and for documentation of the processes in a complex organizational setting. Process modelling aims human understanding and adoption of the technical and organizational activities of a business to reach operational performance. Similarly, visualization of EPIs on process models targets human understanding of the environmental impact of the technical and organizational activities of a business to achieve environmental performance objectives and to facilitate change towards processes with less environmental impact. I systematically identified and reviewed relevant Green BPM [12] literature and analyzed it based on its contributions to ES. I conducted another systematic and tool-supported literature review on three sets of Green IT, Green IS and BPM literature, looking for core EPIs and relevant contributions. Exploring the studies in Green IS literature indicated a broad range from designing suitable information systems, to extending methods and frameworks for Green IS [13], measuring and monitoring performance and energy efficiency of an information system and motivating the need for integrated systems that involve Green concepts [14]. Several literature reviews [15-17] identified and classified the majority of studies in Green IS as conceptual studies focusing on introduction and discussion of benefits of ES in IS and suggested further investigation into applicability and successful implementation and execution of proposed Green IS techniques. I conducted a third systematic and tool-supported review on Green BPM literature to identify the different types of theoretical contributions [2] [1]. Research in Green BPM literature has scarcely addressed the problem raised above, even though the problem is considered critical for industry. Indeed, Green BPM research has more to offer to stay relevant to the needs of industry [2, 18, 19].

[1] An updated and extended version of this paper is currently under review in the *Australasian Journal of Information Systems* (AJIS)

4 Theoretical underpinnings

Business process modelling is a technique that uses words and graphics to visualize business process information for process users. The cognitive theory of multimedia learning (CTML) [20] explains how process users understand better when presented with process models which are visual representations of business processes. CTML [20] serves as a background theory informing the effective presentation of EPI process notation using words and graphics. Based on CTML [20], the EPI process notation needs to be enriched with textual descriptions, in order to improve cognitive processing and understanding of the information. However, CTML does not provide guidelines on the design of notations. Therefore, I use guidelines from the physics of notations theory [21] to define syntactic, semantic, pragmatic and semiotic specifications of EPIs and, therefore, effectively design and evaluate visualized EPI process notation. Effectiveness for visual notations is described by Moody [21] and Larkin and Simon [22] as cognitive effectiveness, which is the human mind's speed, ease and accuracy in processing visual representations. In addition to the above theories, to develop a meaningful measurement scale for decision-makers in regard to EPIs on business processes, I use fuzzy set theory [23], which is a mathematical approach to overcome ambiguity in decisions made regarding the environmental impact of the activities and processes.

5 Methodology

Design theory [24] and design science [25] guide the overarching methodology of this research. I am using a multi-perspective approach in my design science methodology and address design theory in two dimensions: main and additional components of IS Design Theory (ISDT) [24] is guiding the construction process of my artefacts. ISDT will inform and explain the process of construction. Design Relevant Explanatory/Predictive Theory (DREPT) by Kuechler and Vaishnavi [26] is used to explain how and why the developed artefacts work the way they do. I have designed my research phases in five iterative steps, following steps [27]: awareness of the problem, suggestion, development, evaluation and reflection; with an emphasis on future modifications of the solution where needed and as proposed by Arnott [28]. I refer to design as a logical process that involves revising the theory and the objective of the design throughout the design process [29]. I present the state of the constructs in my DS process in a model consisting D (Description of current design candidate), K (Knowledge available) and P (Properties of current design candidate or specifications). If I have a D and K, then P, the properties of current design specifications, could be deducted. Through the phases of design, new states for Design candidate (D') is achieved, if new Knowledge (K') and new Properties (P') are developed. To evaluate the design science artefacts and the developed solution, a preliminary case study has been conducted. Several interviews are being conducted with domain experts in hospitality, in conceptual modelling and environmental auditors. The interviews are designed to inform the EPI process notation design, according to design principles in the physics of notation [21]. In addition, action

design research will be conducted to evaluate the effectiveness [31] of the design science artefacts in the context of problem domain: hospitality industry.
The hospitality industry has been the largest of the business sectors in the world economy since the 1990s. It has been a fast-growing sector worldwide [30], it is known for its high consumption of natural resources and energy[31] and therefore is under pressure to reduce its environmental impact. This pressure, together with societal expectations and community pressure from customers [32], financial gain [33], environmental regulatory organizations [34], market competition [35] and gaining unique competitive advantage [36] have all led the hotel industry to attract much research and practice interest in ES [37]. Findings from first round of case studies indicated that the existing methods do not reflect the environmental efficiency of operations and therefore, hotels are unable to measure, improve and manage the environmental impact on operational level.

6 Project state

In transition from the awareness to the suggestion phase of the project, I conducted a case study on five medium-large sized hotels using interviews and document analysis methods. Prevalent findings confirmed the identified problem that although there are internal programs, operational efforts and certifications being adopted by hotels to manage their environmental objectives, hotels still experience challenges in identifying, measuring, analyzing, benchmarking, communicating and monitoring the environmental impact of their operational areas. The interview questions covered several concepts categorized as 1) ES as competitive advantage; 2) environmental performance objectives for organizations; 3) controlled use of environmental resources by measuring, controlling and monitoring the EPIs; 4) planning, communication and motivation for ES in hotel operations; 5) employee awareness regarding ES practices; and 6) BPM. All hotels appreciated ES as source of competitive advantage, while most participants had no clear definition for environmental objectives, nor had an external auditor to liaise with in order to reduce their environmental impact. Surprisingly, I found the complete absence of BPM initiatives in interviewed hotels. A first draft of the EPI notation is developed using business process model and notation (BPMN) and EPI notation constructs. In the current phase of design process, EPI process notation is being presented to domain experts in hospitality, conceptual modelling and environmental auditors in order to collect opinions about the design aspects. The identification and measurement of EPIs is being developed using a fuzzy logic approach [38] and will be evaluated through the cycles of design and evaluation. In the reflection phase, I intend to reflect on the contribution of this research and the rigor and relevance of the conducted research and designed artefacts. Moreover, I will revisit the knowledge contribution to design theory. My PhD project is expected to be completed and submitted by July of 2021.

References

1. McWilliams, A., Siegel, D.S.: Creating and capturing value: Strategic corporate social responsibility, resource-based theory, and sustainable competitive advantage. Journal of Management 37, 1480-1495 (2011)
2. Roohy Gohar, S., Indulska, M.: Business process management: saving the planet? In: Australasian Conference on Information Systems (ACIS). (2015)
3. Hammer, M.: What is business process management? In: Rosemann, J.v.B.M. (ed.) Handbook on business process management: Introduction, methods and information system, vol. 1, pp. 3-16. Springer, Berlin, Germany (2010)
4. Rosemann, M., vom Brocke, J.: The six core elements of business process management. Handbook on Business Process Management 1, pp. 105-122. Springer (2015)
5. Recker, J.C.: X-aware business process management. BP Trends 8, 1-7 (2011)
6. Recker, J., Rosemann, M., Hjalmarsson, A., Lind, M.: Modeling and Analyzing the Carbon Footprint of Business Processes. In: vom Brocke, J., Seidel, S., Recker, J. (eds.) Green Business Process Management, pp. 93-109. Springer Berlin Heidelberg (2012)
7. Wesumperuma, A., Ginige, J.A., Ginige, A., Hol, A.: A Framework for Multi-dimensional Business Process Optimization for GHG Emission Mitigation. (2011)
8. Wesumperuma, A., Ginige, A., Ginige, J., Hol, A.: Green activity based management (ABM) for organisations. In: 24th Australasian Conference on Information Systems (ACIS), pp. 1-11. RMIT University, (2013)
9. Cappiello, C., Plebani, P., Vitali, M.: Energy-aware process design optimization. In: Cloud and Green Computing (CGC), 2013 Third International Conference on, pp. 451-458. IEEE, (2013)
10. Rosemann, M., Recker, J.C., Flender, C., Ansell, P.D.: Understanding context-awareness in business process design. (2006)
11. Conforti, R., Fortino, G., La Rosa, M., Ter Hofstede, A.H.: History-aware, real-time risk detection in business processes. In: OTM Confederated International Conferences " On the Move to Meaningful Internet Systems", pp. 100-118. Springer, (Year)
12. Seidel, S., Recker, J., Brocke, J.: Green Business Process Management. In: vom Brocke, J., Seidel, S., Recker, J. (eds.) Green Business Process Management, pp. 3-13. Springer Berlin Heidelberg (2012)
13. Bodenbenner, P., Feuerriegel, S., Neumann, D.: Design science in practice: designing an electricity demand response system. Design Science at the Intersection of Physical and Virtual Design, pp. 293-307. Springer (2013)
14. Corbett, J.: Designing and Using Carbon Management Systems to Promote Ecologically Responsible Behaviors. Journal of the Association for Information Systems 14, 339-378 (2013)
15. Brooks, S., Wang, X., Sarker, S.: Unpacking Green IS: A Review of the Existing Literature and Directions for the Future. In: vom Brocke, J., Seidel, S., Recker, J. (eds.) Green Business Process Management, pp. 15-37. Springer Berlin Heidelberg (2012)
16. Esfahani, M.D., Rahman, A.A., Zakaria, N.H.: The Status Quo and the Prospect of Green IT and Green IS: A Systematic Literature Review. Journal of Soft Computing and Decision Support Systems 2, 18-34 (2015)
17. Esfahani, M.D., Rahman, A.A., Zakaria, N.H.: Journal of Soft Computing and Decision Support Systems. Journal of Soft Computing and Decision 2, (2014)
18. Applegate, L.M., King, J.L.: Rigor and relevance: careers on the line. Management Information Systems Quarterly 23, 17-18 (1999)

19. Rosemann, M., Vessey, I.: Toward improving the relevance of information systems research to practice: the role of applicability checks. MIS Quarterly 1-22 (2008)
20. Mayer, R.E.: Multimedia learning. Psychology of Learning and Motivation 41, 85-139 (2002)
21. Moody, D.: The “physics” of notations: toward a scientific basis for constructing visual notations in software engineering. IEEE Transactions on Software Engineering 35, 756-779 (2009)
22. Larkin, J.H., Simon, H.A.: Why a diagram is (sometimes) worth ten thousand words. Cognitive science 11, 65-100 (1987)
23. Zadeh, L.A.: Fuzzy sets. Information and Control 8, 338-353 (1965)
24. Gregor, S., Jones, D.: The anatomy of a design theory. Journal of the Association for Information Systems 8, 312-335 (2007)
25. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design science in information systems research. MIS quarterly 28, 75-105 (2004)
26. Kuechler, W., Vaishnavi, V.: A framework for theory development in design science research: multiple perspectives. Journal of the Association for Information systems 13, 395 (2012)
27. Vaishnavi, V.K., Kuechler, W.: Design science research methods and patterns: innovating information and communication technology. Crc Press (2015)
28. Arnott, D.: Cognitive biases and decision support systems development: a design science approach. Information Systems Journal 16, 55-78 (2006)
29. Takeda, H., Veerkamp, P., Yoshikawa, H.: Modeling design process. AI magazine 11, 37 (1990)
30. World-Tourism-Organization: Global forecasts and profiles of market segments. (2000)
31. Bohdanowicz, P.: Environmental awareness and initiatives in the Swedish and Polish hotel industries—survey results. International Journal of Hospitality Management 25, 662-682 (2006)
32. Chan, E.S., Hawkins, R.: Attitude towards EMSs in an international hotel: An exploratory case study. International Journal of Hospitality Management 29, 641-651 (2010)
33. González, M., León, C.J.: The adoption of environmental innovations in the hotel industry of Gran Canaria. Tourism Economics 7, 177-190 (2001)
34. Bohdanowicz, P., Zientara, P., Novotna, E.: International hotel chains and environmental protection: an analysis of Hilton's we care! programme (Europe, 2006–2008). Journal of Sustainable Tourism 19, 797-816 (2011)
35. Jones, P., Hillier, D., Comfort, D.: Sustainability in the hospitality industry: Some personal reflections on corporate challenges and research agendas. International Journal of Contemporary Hospitality Management 28, 36-67 (2016)
36. Leonidou, L.C., Leonidou, C.N., Fotiadis, T.A., Zeriti, A.: Resources and capabilities as drivers of hotel environmental marketing strategy: Implications for competitive advantage and performance. Tourism Management 35, 94-110 (2013)
37. Chou, C.-J.: Hotels' environmental policies and employee personal environmental beliefs: Interactions and outcomes. Tourism Management 40, 436-446 (2014)
38. Awasthi, A., Chauhan, S.S., Goyal, S.K.: A fuzzy multicriteria approach for evaluating environmental performance of suppliers. International Journal of Production Economics 126, 370-378 (2010)