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Book of industry papers, poster papers and abstracts

2021
October 13-15, Braga
Portugal

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Preface

The co-located conferences CENTERIS'2021, ProjMAN'2021 and HCist'2021 provided an excellent conference environment for sharing best practices among researchers, academics and professionals from both generic Enterprise, Project Management and specific Healthcare Information Systems research areas.

CENTERIS – Conference on ENTERprise Information Systems – is an international conference addressing the largely multidisciplinary field embraced by Enterprise Information Systems (EIS), from the social, organizational and technological perspectives.

ProjMAN – International Conference on Project MANagement – addresses the application of knowledge, skills, methods, techniques and tools to the activities of a project, aiming to satisfy its requirements and achieve success at several levels. A plethora of valuable technical and business opportunities and solutions are created and developed all the time only thanks to good practices of project management.

HCist – International Conference on Health and Social Care Information Systems and Technologies – intends to gather Healthcare Information Systems and Technologies professionals and academics to share and discuss current challenges, developments, case studies, integrated and practical solutions, as well as new products, findings and approaches to leverage the use of Information Systems and Technologies in healthcare.

Due to the COVID-19 pandemic, this year the Organizing Committees of the three conferences implemented a hybrid and inclusive format, allowing face-to-face and remote participation, to meet the needs of those who, during the period of submission of manuscripts, were not sure about traveling and/or gathering resources to participate in person.

The physical venue for CENTERIS'2021, ProjMAN'2021 and HCist'2021 was Braga, Portugal, conveying both face-to-face and virtual (remote) presentations. This was the place where, during October 13-15, under the *leitmotiv* of Enterprise Information Systems, Project Management, and Health/Social care Information Systems, academics, scientists, information

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technologies/information systems professionals, managers and solution providers from all over the world had the opportunity to share experiences, bring new ideas, debate issues, introduce the latest developments, from the social, organizational and technological perspectives.

More than 230 manuscripts were submitted to CENTERIS, ProjMAN and HCist, coming from all over the world, and 128 of them were selected for presentation and inclusion in the conference proceedings. Nearly 15 industry and poster papers were also accepted for presentation. The selected papers represent nearly 400 authors from academic, research institutions and industry, from 40 countries. These proceedings are intended for use by academics and practitioners that want to be aware of what is currently in the Information Systems agenda, from research to everyday business practice.

Finally, on behalf of the organization, we would like to express our gratitude to all the authors, for their visions and excellent contributions to the conferences, as well as to the scientific committee members, who acceded to share their insights, prompt collaboration and constructive comments in the reviewing process. We are also grateful to all who submitted valuable and high-quality contributions but unfortunately and due to several constraints, could not see their work accepted for presentation and publication.

Enjoy your reading!

October 2021,

The editors,

António Cunha
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Acknowledgements

Organizing a conference is a very hard but compensating and enriching experience, as it involves a complex set of different activities, from the design of the conference, the establishment of the scientific commission, contacts with authors, organization of the review process, discussion and exchange of ideas and experiences, process management, organization and integration of contents, and many other, with the permanent objective of preparing an event that meets the participants' expectations. And this task cannot be accomplished without a great help and support from many sources. As conference co-chairs, we would like to acknowledge the help, support and believe of all who made possible the creation of CENTERIS/ProjMAN/HCIST.

We are grateful to all the authors who have chosen CENTERIS/ProjMAN/HCist 2021 to present their work, thank you, you made both conferences happen! Our gratitude goes also to all the authors that submitted their proposals but were not able to see their work accepted, due to several constraints.

The Scientific Committees of CENTERIS, ProjMAN and HCist integrates now more than 300 individualities, most of them who shared their knowledge and gave their constructive comments indispensable to the decision-making associated with the selection process, to whom we express our gratitude.

We are also grateful to the conference sponsors that played a very relevant role and to the scientific journals who offered the chance to publish enhanced versions of selected papers.

BSRJ - Business Systems Research Journal
IJBAN - International Journal of Business Analytics
IJESMA - International Journal of E-Services and Mobile Applications
IJHCITP - International Journal of Human Capital and Information Technology Professionals
IJISPM - International Journal of Information Systems and Project Management
IJISSC - International Journal of Information Systems and Social Change
IJISSS - International Journal of Information Systems in the Service Sector
IJITPM - International Journal of Information Technology Project Management
IJWP - International Journal of Web Portals

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Finally, a word of appreciation is due to the members of the organising committee for their prompt and friendly support.

The Conference Chairs,

Maria Manuela Cruz-Cunha
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A Customizable Web Platform to Manage Standards Compliance of Information Security and Cybersecurity Auditing

Mário Antunes[a,c], Marisa Maximiano[a], Ricardo Gomes[b]

[a]*Computer Science and Communication Research Centre (CIIC), School of Technology and Management, Polytechnic of Leiria; Leiria, Portugal*
[b]*School of Technology and Management, Polytechnic of Leiria; Leiria, Portugal*
[c]*INESC TEC, CRACS, Porto, Portugal*

Abstract

Information security and cybersecurity are key subjects in modern enterprises' management, being ISO-27001:2013, NIST Cybersecurity Framework and ISO-27009 some of the most implemented international frameworks and standards. Their main goal is to globally reduce the risk, by leveraging enterprises' competitiveness in global markets and enhancing business processes and collaborators' cyber awareness. Auditing processes examine and assess a list of predefined controls. For each control, a set of corrective measures could be proposed, to increase its compliance with the standard being used. These processes are time-consuming, involve on-site intervention by specialized consulting teams on the intervened enterprises, and a set of status reports of all the interventions should be elaborated and delivered. The existing auditing information systems are not developed to meet Small and Medium-sized Enterprises (SME) requirements, as they are mostly proprietary and expensive, ground usually on off-the-shelf applications, and are not generic to be used by several standards with different checklists and auditing methodologies. In this paper, a generic and web-integrated cybersecurity auditing information system is described. Its architecture, design, and data model enable it to be used in a wide set of auditing processes, by loading a predefined controls checklist assessment and their corresponding mitigation tasks list. It was designed to meet both SMEs and large enterprises' requirements, and stores auditing and intervention-related data in a relational database. The information system was tested on an ISO-27001:2013 information security auditing project, which has integrated fifty SMEs. The results obtained during the project are promising and reveal the appropriateness of using this information system in further similar auditing processes.

Keywords: Cybersecurity, Information Security, Auditing, ISO-27001, Small and Medium-sized Enterprises.

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A Gender Perspective on GDPR and Information Privacy

Hanne Sørum, Ragnhild Eg, Wanda Presthus

Kristiania University College, Kirkegaten 24-26, 0153 Oslo, Norway

Abstract

With the introduction of The General Data Protection Regulation (GDPR) in 2018, European citizens were granted stronger privacy protection. Despite privacy and GDPR being frequent topics of discussion, many consumers lack knowledge on how personal data are harvested for business purposes, and they are unaware of their rights. Drawing on a larger survey conducted in a Norwegian university college, this study investigates gender differences in privacy behaviour (n=444). We offer three insights. The results revealed that (1) respondents' concern for privacy does not differ across gender, but men claimed to experience slightly more control over their personal data compared to women. (2) Exercising privacy rights were comparable across gender as women and men reported the same inclination to act on rights granted by GDPR. (3) Willingness to share information in return for benefits depended on the information in question. Men and women agreed in their willingness to exchange name and e-mail. However, women were less willing than men to give up more sensitive information, yet more willing to give up date of birthday, TV viewing history and shopping history. Our insights bring attention to a possible link between experienced control over own data and willingness to exchange data for benefits, highlighting a potential mediating relationship that could be worthwhile pursuing.

Keywords: Gender difference; General Data Protection Regulation (GDPR); concern for privacy; exercising rights; privacy measures.

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A graph based recommender system for managing Covid-19 Crisis

Yemna Sayeb, Marwa Jebri, Henda Ben Ghezala

RIADI, National School of Computer Sciences, Manouba University, Tunisia

Abstract

The paper aims to present a graph based recommender system for managing the Covid-19 crisis by considering patient and medical staff data. Working with limited number of medical staff, require optimization when creating the appropriate medical staff to assist patient. Patient medical files usually contain more information about the patient diseases and symptoms. In this paper the recommender system at first analyses the patient medical files to find and decide which profile of medical staff could assist efficiency this patient in a crisis situation. Second the recommender system by taking into account the availability of the medical staff will try to propose others doctors with the same profile and the nearest competencies.

Keywords: recommender system, Covid-19 crisis, graph model.

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A Ubiquitous Service-Oriented Automatic Optical Inspection Platform for Textile Industry

Dibet Garcia Gonzalez[a] Yusbel Chavez Castilla[a], Somayeh Shaharadaby[a], Ana Mackay[a], Lúcia Soares[a], Pedro Guimarães[a], Francisco Morais[a], Joel Puga[a], Filipe Meneses[a,b], Adriano Moreira[a,b], Miguel Machado[c], Telmo Adão[a], Luís Magalhães[a], Miguel Angel Guevara López[a]

[a]Center for Computer Graphics, Campus de Azurém, Edifício 14, Guimarães, 4800-058, Braga, Portugal
[b]Algoritmi Research Center, University of Minho, Guimarães, 4800-058, Portugal
[c]ERT Group. Av 1o Maio – Z.I. Travessas. Apartado 181. 3701-911, São João da Madeira, Portugal

Abstract

Within a highly competitive market context, quality standards are vital for the textile industry, in which related procedures to assess respective manufacture still mainly rely on human-based visual inspection. Thereby, factors such as ergonomics, analytical subjectivity, tiredness and error susceptibility affect the employee's performance and comfort in particular and impact the economic healthiness of each company operating in this industry, generally. In this paper, a defect detection-oriented platform for quality control in the textile industry is proposed to tackle these issues and respective impacts, combining computer vision, deep learning, geolocation and communication technologies. The system under development can integrate and improve the production ecosystem of a textile company through a properly adapted information technology setup and associated functionalities such as automatic defect detection and classification, real-time monitoring of operators, among others.

Keywords: Automatic Optical Inspection; Computer Vision; Deep Learning; Textile Industry; Indoor Positioning; Microservices Architecture.

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A web-based Voice Interaction framework proposal for enhancing Information Systems user experience

Tiago F. Pereira[a] , Arthur Matta[a], Carlos M. Mayea[a], Frederico Pereira[a], Nelson Monroy[b], João Jorge[b], Tiago Rosa[b], Carlos E. Salgado[a], Ana Lima[a], Ricardo J. Machado[c], Luís Magalhães[c], Telmo Adão[a], Miguel Ángel Guevara López[a], Dibet Garcia Gonzalez[a]

[a]*Center for Computer Graphics, Campus de Azurém, Edifício 14, Guimarães, 4800-058, Braga, Portugal*
[b]*PHC, Av. Prof. Dr. Cavaco Silva 7A, Porto Salvo, Lisboa, 2740-120, Portugal*
[c]*Minho University, Campus de Azurém, Edifício 14, Guimarães, 4800-058, Braga, Portugal*

Abstract

Nowadays, numerous organisations of different dimensions and business sectors operate in highly challenging and dynamic environments, wherein the supporting information systems (IS) are becoming increasingly complex. In this context, assistive tools capable of tackling such complexity have the potential to aid users improving their performance and effectiveness, as well as to streamline businesses' processes and promote entrepreneurial-level competitivity. Following this line of research, a web-based speech-to-term recognition approach is presented as a solution to endow IS with advanced capabilities for providing an easier (more natural) and straightforward interaction with baseline functionalities, by combining relevant techniques such as Voice Activity Detection (VAD), Automatic Speech Recognition (ASR), Natural Language Processing (NLP), and an Ontological Database (OD), mapping the IS' functionalities and characteristics, is proposed. The developed interoperable system allows the conversion of speech to text - deriving into IS instructions - that is, in turn, submitted to on an ontological database wherein a term-based query is performed to elicit a set of available commands to be executed in the web context. These commands, fully mapped in the ontological database, are divided into three categories: a) navigation by menus/links, b) buttons interaction (e.g., submit forms) and c) completion of form fields. The proposed framework was experimentally tested in close to real conditions, resorting to an Enterprise Resource Planning (ERP) tool supplied by ERP Company.

Full paper available online at SciVerse ScienceDirect (www.sciencedirect.com).

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Keywords: Automatic Speech Recognition; Deep Learning; Voice Activity Detection; Ontologies; Graph Database; Ontological Component; Semantic Interoperability.

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A Workspace Typology for Enterprise Collaboration Systems

Sebastian Bahles, Florian Schwade, Petra Schubert

University of Koblenz, Center for Enterprise Information Research, Universitaetsstr. 1, 56070 Koblenz, Germany

Abstract

The global COVID-19 pandemic and the need for organisations to provide digital support for work-from-anywhere has put collaboration software into the centre of attention for IT managers. In this paper we examine (self-managed) workspaces in (integrated) Enterprise Collaboration Systems (ECS) that provide the environment for asynchronous communication and exchange of information. Our aim is to better understand how employees use the ECS to support their work. Based on a structured literature review and an in-depth case study of an ECS user company we developed a generic typology of workspaces containing three main categories (community, team and non-work-related) and 5 different types of workspaces. The types are characterised by their purpose, characteristics and possible metrics for their identification. The findings contribute to our understanding of collaborative user activity in enterprise collaboration environments and provide the basis for Social Collaboration Analytics.

Keywords: Enterprise Collaboration Systems, CSCW, Topology, Workspaces.

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Academic Procrastination and Online Learning During the COVID-19 Pandemic

Jørgen Melgaard, Rubina Monir, Lester Allan Lasrado, Asle Fagerstrøm

Kristiania University College, School of Economics, Innovation and Technology, 0152 Oslo, Norway

Abstract

This paper investigates online learning during the COVID-19 pandemic and explores the possibility that procrastinators have been impacted differently as compared to others. The research is explorative in nature and employs interviews from participants at a higher education institution in Norway as a primary method of investigation. The preliminary findings presented in the paper highlight differences between procrastinators and non-procrastinators regarding the desire to study and satisfaction with learning outcomes. The procrastinators are encountering a higher degree of challenges related to motivation as opposed to non-procrastinators. The preliminary findings also highlight challenges associated with student engagement and the use of the camera during online classes for all the students.

Keywords: COVID-19, Online Learning, Distance Learning, Procrastination.

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An investigation of smart water meter adoption factors at universities

Mogamad Nieyaaz Adams, Osden Jokonya

University of the Western Cape, Bellville, Cape Town 7535, South Africa

Abstract

The study investigates the factors affecting the adoption of smart water meters in universities. The study used a systematic literature review to explore factors affecting the adoption of smart water meters using secondary data. The Technology, Organisation, Environment (TOE) Framework was used as a theoretical lens to identify themes that affect the adoption of smart water meters. The study adopts the quantitative content analysis to identify adoption factors from published literature on smart water meters. The collected was analyzed quantitatively to reveal factors affecting the adoption of smart water meter technologies. The study results suggest that technological factors are the most popular adoption factors affecting the adoption of smart meter technology. Environmental factors are the second important factor affecting the adoption of smart meter technology. The organizational factors were the least important factors affecting the adoption of smart meter technology in organizations. The research contributes to the body of knowledge on factors affecting smart water adoption in universities. In addition, the study stimulates further research in the area using empirical and other research methods.

Keywords: Smart water, Adoption, big data, IOT, TOE, Smart Meter.

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Algorithms to analyze the impact of change on Enterprise Architecture

Imgharene Kawtar, Doumi Karim, Baina Salah

Alqualsadi team, ENSIAS Mohammed V University in Rabat, Rabat, Morocco

Abstract

Currently, the organizations are constantly confronted with rapid and radical changes, making the company in turbulence that requires a transformation from a state to a target state. This turbulence needs agility on the part of companies, i.e. the ability to monitor their environment and be ready to react. Enterprise architecture needs transformation if its levels of abstraction are affected by its changes, so enterprise architecture needs to be agile to evolve over time. To measure the impact of change on the abstraction levels. This article proposes different algorithms to proceed to the change impact analysis in the different abstraction levels to be able to analyze the change impact of different projects on the elements of the enterprise architecture and to make it agile.

Keywords: Change ; Enterprise Architecture ; Algorithms ; impact analyze.

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Analysis of critical success factors to mitigate privacy risks in IoT Devices

Sitesh Mohanty, Kathryn Cormican, Chandrasekhar Dhanapathi

Enterprise Research Centre, School of Engineering and Lero – the Irish Software Research Centre, National University of Ireland, Galway

Abstract

This research aims to ascertain how to effectively mitigate privacy risks in IoT devices. A user-centric approach is employed to increase user control and flexibility. After a detailed analysis of the extant literature, critical success factors that are lauded to alleviate risks in IoT devices were synthesised and collated. These include anonymity, transparency, simplicity, explicit consent and GDPR. An instrument was developed based on these factors to ascertain which of these aspects are considered to be the most effective. Data were collected and analysed from 341 IoT device users, data protection/IT professionals, and IoT device manufacturers in the industry. Findings from this analysis reveal that transparency is the most important critical success factor, followed by GDPR, anonymity, explicit consent, and simplicity, respectively. Based on these findings, a self-assessment scorecard was developed to enable analysts and decision-makers to assess their current performance against best practices and to effectively mitigate privacy risks in IoT devices.

Keywords: Privacy, Internet of Things (IoT); Smart Devices; User-Centric; GDPR; Explicit Consent; Anonymity; Transparency; Simplicity; Privacy Scorecard.

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Analyzing the Fine Tuning's impact in Grapevine Classification

Gabriel S. Carneiro[a], Ana Ferreira[a], Raul Morais[a,b], Joaquim J. Sousa[a,b] and António Cunha[a,b]

[a]*University of Trás-Os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[b]*INESC-TEC ' INESC Technology and Science, Porto, 4200-465, Portugal*

Abstract

Wine is one the most important products from Portugal, being the grapevine variety very important to ensure uniqueness, authenticity and classification. In the Douro Demarcated Region, only certain grapevine varieties are allowed, implying the need for an identification mechanism. The ampelographs, professionals that use visual analysis to classify grapevines, are disappearing. In this situation, one possible replacement for ampelographs can be deep learning models. In previous experiments, we successfully classified 12 grapevines varieties, fine-tuning the Xception model, achieving ~0.9 in F1 score, raising the question, "*what is the impact of the fine-tuning layers' configuration in our results?".*
This paper presents an analysis of the impact of different layers' configuration in fine-tuning Xception model to classify 12 grapevine varieties with images acquired in a natural environment. Despite the model achieved F1-score of 0.92 in all configurations, using the Grad-CAM approach, we show that layers' configuration in fine-tuning implies the quality of the models' prediction. As analysis' result, we can see that the model acting as feature extractor and fully fine-tuned obtains similar results in terms of metrics and pixel contribution, and fine-tuning only the last two blocks lead the model to look at more features in the image.

Keywords: convolutional neural network; explainable artificial intelligence; grad-cam; xception

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Asynchronous Backtracking variant applied to a rolls replacement process within a wire rod mill

Ana María Valdeón Junquera, Vicente Rodríguez Montequín, Joaquín Manuel Villanueva Balsera, Javier García González

University of Oviedo, C/Idependencia 13,33004 Oviedo, Spain

Abstract

There is a wide number of application problems included in multi-agent systems and distributed artificial intelligence which can be described as the issue of finding a consistent combination satisfying all the existing inter-agent constraints, that is, they are distributed constraint satisfaction problems (DisCSPs). In this paper, a new technique for solving such kind of issues when they can be modelled as a succession of interrelated elements with constraints among an agent and its immediately following, having one of the agents the ability to notify either that the problem has been solved or that there are not any possible solutions, is presented. It has been developed using Asynchronous Backtracking, one of the most known algorithms for solving DisCSPs as a basis. To validate its applicability, it has been tested in a wire rod rolling mill for rolls replacement decision making process. It was implemented using the PADE multi-agent framework. The results demonstrate the method is valid to solve this kind of problems usually solved with recursive algorithms such as backtracking.

Keywords: Asynchronous Backtracking; Wire rod mill; DisCSP.

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Automatic detection of Flavescense Dorée grapevine disease in hyperspectral images using machine learning

Diogo M. Silva[a], Théo Bernardin[c], Kévin Fanton[c], Roshan Nepaul[c], Luís Pádua[a], Joaquim J. Sousa[a,b], António Cunha[a,b]

[a]Universidade de Trás-os-Montes e Alto Douro, Quinta de Prado, 5000-811 Vila Real, Portugal
[b]Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência,Porto 4200-465, Portugal
[c]Polytech Annecy-Chambéry, 2 Av. du Lac d'Annecy, 73370 Le Bourget-du-Lac, France

Abstract

The technological revolution that we have been witnessing recently has allowed components miniaturization and made electronic components accessible. Hyperspectral sensors benefited from these advances and could be mounted on unmanned aerial vehicles, which was unthinkable until recently. This fact significantly increased the applications of hyperspectral data, namely in agriculture, especially in the detection of diseases at an early stage. The vineyard is one of the agricultural sectors that has the most to gain from the use of this type of data, both by the economic value and by the number of diseases the plants are exposed to. The Flavescense dorée is a disease that attacks vineyards and may conduct to a significant loss. Nowadays, the detection of this disease is based on the visual identification of symptoms performed by experts who cover the entire area. However, this work remains tedious and relies only on the human eye, which is a problem since sometimes healthy plants are torn out, while diseased ones are left. If the experts think they have found symptoms, they take samples to send to the laboratory for further analysis. If the test is positive, then the whole vine is uprooted, to limit the spread of the disease. In this context, the use of hyperspectral data will allow the development of new disease detection methods. However, it will be necessary to reduce the volume of data used to make them usable by conventional resources. Fortunately, the advent of machine learning techniques empowered the development of systems that allow better decisions to be made, and consequently save time and money. In this article, a machine learning approach, which is based on an Autoencoder to automatically detect wine disease, is proposed.

Keywords: Hyperspectral images; grapevine diseases; automatic detection; autoencoder; machine learning.

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Basic digital competence in Norwegian banking

Julie Norveel[a], Rolando Gonzalez[b], Wanda Presthus[b]

[a]Deloitte AS, Dronning Eufemias gate 14, 0103 Oslo, Norway
[b]Kristiania University College, Kirkegaten 24-26, 0153 Oslo, Norway

Abstract

While the 21st century is crowded with disruptive technologies and ground-breaking innovations, this study will take a step back and explore basic digital competence, such as navigating a spreadsheet or using word processing tools and e-mail to conduct tasks at work. Based on a case study approach where data is derived from iterative testing of 213 employees in the banking sector and 10 semi-structured interviews, we contribute to the literature of information infrastructure and knowledge management by addressing the basic digital level of competence amongst employees. We found that the level of basic digital competence was surprisingly low, especially regarding spreadsheets; however, our analysis revealed that the skills can be quickly improved. The challenge is rather to make employees aware of the possibilities and benefits of improvement. This paper presents insights that should be useful for employees and managers in banks and similar industries. It also reminds researchers within information systems to pay attention to basic digital competence.

Keywords: Basic Digital Competence; Norwegian Banking Sector; Information Infrastructure; Knowledge Infrastructure.

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Blockchain-enabled Sustainability Labeling in the Fashion Industry

Anne-Marthe Rekdal Remme, Stine-Mari Stange, Asle Fagerstrøm, Lester Allan Lasrado

Kristiania University College, School of Economics, Innovation and Technology, 0152 Oslo, Norway

Abstract

This study explores the relative impact of blockchain-enabled sustainability labeling on consumers purchasing behavior when shopping for fashion products. A conjoint experiment was conducted where participants (n=84) assigned scores to stimuli cards according to preference in a specific shopping scenario. Results showed that "blockchain trademarked" did not have much impact relative to "low price" and "high product rating". Further analysis showed that "blockchain trademarked" had a relatively stronger impact towards those participants (n=22) who indicated that living a sustainable lifestyle is important. Our findings show that there is a need for educating consumers about blockchain and the associated benefits for improving future transparency in sustainability in the fashion industry. Overall, these findings provide valuable grounds for further research on how blockchain-enabled sustainability labeling can create value for both consumers and companies within the fashion industry.

Keywords: blockchain-enabled sustainability labeling; fashion industry; conjoint experiment.

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Contributions to the design of mobile applications for visitors of Botanical Gardens

Stefan Postolache[a], Rafael Torres[a], Ana Paula Afonso[a], Maria Beatriz Carmo[a], Ana Paula Cláudio[a], Dulce Domingos[a], António Ferreira[a], Raquel Barata[b,c], Palmira Carvalho[b], Ana Godinho Coelho[b], Maria Cristina Duarte[c,d], César Garcia[b,c], Ana Isabel Leal[c,e], Paula Redweik[f,g]

[a]*LASIGE, Departamento de Informática, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*
[b]*Museu Nacional de História Natural e da Ciência, Universidade de Lisboa, Lisboa, Portugal*
[c]*Centre for Ecology, Evolution and Environmental Changes (cE3c), Lisboa, Portugal*
[d]*Departamento de Biologia Vegetal, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*
[e]*Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*
[f]*Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*
[g]*Departamento de Engenharia Geográfica, Geofísica e Energia, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*

Abstract

Botanical Gardens are among the most visited touristic attractions, offering scientific, educational, cultural and leisure activities to preserve and enhance heritage and disseminating specialised knowledge on science and history. There are several mobile applications (apps) to support visitors of Botanical Gardens, which explore augmented reality technologies to enrich their experience. Our work aims to systematize a set of requirements that must be considered in the development of these apps. We have applied them in the development of an app for a Botanical Garden available for Android and iOS. Preliminary data analysis of the use of our app revealed some characteristics of the visitors and the preferred tours. Meanwhile we are evaluating our app by conducting a user study.

Keywords: Mobile Applications; Botanical Gardens; Augmented Reality.

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Cultural Values in Digital Transformation in a Small Company

Veera Tuukkanen, Emma Wolgsjö, Lazar Rusu

Stockholm University, Borgarfjordsgatan 12, 164 07 Kista, Sweden

Abstract

Researchers and practitioners have found culture to be very important to digital transformation. However, despite the widespread consensus about the importance of culture in successful digital transformations, only a limited number of studies have explicitly focused on the cultural aspects in digital transformation in small and medium-sized companies (SMEs). This research investigates and analyses the important cultural values in digital transformation in a small company operating in the IT industry. The findings of this study are nine organisational values, from which eight values show similarities to the existing research. In contrast, the organisational value entitled "affinity towards the organisation" has been identified as a new organisational value in digital transformation in small companies. The identified cultural values can raise the awareness of organisations' management planning or currently engaged in a digital transformation and help organisations recognise cultural values that can contribute to digital transformation initiatives' success or failure.

Keywords: Digital Transformation, Organisational Culture, Cultural Values, SMEs.

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Customer reviews sentiment-based analysis and clustering for market-oriented tourism services and products development or positioning

Sandra Jardim, Carlos Mora

Smart Cities Research Center, Polytechnic Institute of Tomar, Quinta do Contador, 2300-313 Tomar, Portugal

Abstract

This paper proposes a method that allows the clustering and identification of similarities between users of a digital tourism platform, through the extraction of the sentiments expressed by them in the reviews or comments registered and the subsequent automatic clustering of the users, according to the polarity of sentiments subjectively expressed in their posts. This research fills a gap in the text mining literature for the development, improvement and/or reorientation of services and products in the field of tourism, providing a method to explore the needs and desires of the client based on their digital footprint drawn from posts and reviews about the service or product in question. The sentiment analysis is detailed, comprehending language detection and some specific language syntax treatment, with a subsequent explanation of the clustering algorithm used. The developed algorithm was tested in the user's segmentation and sentiment analysis of their publications on a digital tourism platform. The results obtained demonstrate the efficiency of the solution, which presents a high accuracy in the classification of publications in four different languages and in the user's segmentation process.

Keywords: sentiment analysis; automatic sentiment classification; lexicon-based approach; customer reviews; customer segmentation.

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Cyber-Physical Systems using Open Design: an approach towards an Open Science Lab for Manufacturing

Hélio Castro[a,b], Nuno Pinto[a], Filipe Pereira[a], Luís Ferreira[c], Paulo Ávila[a,b], João Bastos[a,b], Goran D. Putnik[d], Manuela Cruz-Cunha[c]

[a]*School of Engineering, Polytechnic of Porto, Rua Dr. António Bernardino de Almeida, 431, 4249-015 Porto, Portugal*
[b]*INESC TEC, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*
[c]*2Ai - Applied Artificial Intelligence Lab, School of Technology, IPCA, Barcelos, Portugal*
[d]*University of Minho, School of Engineering, Campus de Azurém, 4800-058 Guimarães, Portugal*

Abstract

Cyber-Physical Systems (CPS) are fundamental in Industry 4.0 and manufacturing research communities, and research and technologies organizations (RTO) are keen to implement CPS laboratories. Due to the strong investment in these laboratories, it is unfordable the investment in CPS laboratories. This paper proposes a CPS architecture based on Open Design (an open-source approach for hardware and software), and the implementation of the laboratory created as an *open-source* and truly *low-cost* solution, designated as Open Science Lab for Manufacturing (OSLab4Man), addressing the reproducibility and replicability (R&R) practices for manufacturing research laboratories. An *open-source* and truly *low-cost* solution of the OSLab4Man and the bill of materials (BOM) of the physical components and some alternative components *open-source* and/or *low-cost* is presented, that enables a ubiquitous manufacturing system.

Keywords: Cyber-Physical System (CPS); Open Design; Open Science; Open Lab; Manufacturing.

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Data Mesh: Concepts and Principles of a Paradigm Shift in Data Architectures

Inês Araújo Machado, Carlos Costa, Maribel Yasmina Santos

University of Minho, ALGORITMI Research Centre, Guimarães, Portugal

Abstract

Inherent to the growing use of the most varied forms of software (e.g., social applications), there is the creation and storage of data that, due to its characteristics (volume, variety, and velocity), make the concept of Big Data emerge. Big Data Warehouses and Data Lakes are concepts already well established and implemented by several organizations, to serve their decision-making needs. After analyzing the various problems demonstrated by those monolithic architectures, it is possible to conclude about the need for a paradigm shift that will make organizations truly data-oriented. In this new paradigm, data is seen as the main concern of the organization, and the pipelining tools and the Data Lake itself are seen as a secondary concern. Thus, the Data Mesh consists in the implementation of an architecture where data is intentionally distributed among several Mesh nodes, in such a way that there is no chaos or data silos, since there are centralized governance strategies and the guarantee that the core principles are shared throughout the Mesh nodes. This paper presents the motivation for the appearance of the Data Mesh paradigm, its features, and approaches for its implementation.

Keywords: Big Data; Data Mesh; Data Architectures; Data Lake.

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Deformation Fringes Detection in SAR interferograms Using Deep Learning

Bruno Silva[a], Joaquim J. Sousa[b,c], Milan Lazecky[d],António Cunha[b,c]

[a]*Faculdade de Ciências da Universidade do Porto,Porto 4169-007, Portugal*
[b]*Universidade de Trás-os-Montes e Alto Douro, Quinta de Prado, 5000-811 Vila Real, Portugal*
[c]*Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência, Porto 4200-465, Portugal*
[d]*COMET, School of Earth and Environment, University of Leeds*

Abstract

The success achieved by using SAR data in the study of the Earth led to a firm commitment from space agencies to develop more and better space-borne SAR sensors. This involvement of the space agencies makes us believe that it is possible to increase the potential of SAR interferometry (InSAR) to near real-time monitoring. Among this ever-increasing number of sensors, the ESA's Sentinel-1 (C-band) mission stands out and appears to be disruptive. This mission is acquiring vast volumes of data making current analyzing approaches inviable. This amount of data can no longer be analyzed and studied using classic methods raising the need to use and create new techniques. We believe that Machine Learning techniques can be the solution to overcome this issue since they allow to train Deep Learning models to automate human processes for a vast volume of data. In this paper, we use deep learning models to automatically find and locate deformation areas in InSAR interferograms without atmospheric correction. We train three state-of-the-art classification models for detection deformation areas, achieving an AUC of 0.864 for the best model (VGG19 for wrapped interferograms). Additionally, we use the same models as encoders to train U-net models, achieving a Dice score of 0.54 for InceptionV3. It is necessary more data to achieve better results in segmentation.

Keywords: Deep learning; Deformation Fringes; InSAR.

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Digital transformation as distributed leadership: Firing the change agent

Anne-Christine Rosfeldt Lorentzen

Aarhus University, Aarhus BSS, Fuglsangsvej 4, Aarhus 8210, Denmark

Abstract

Literature has tended to describe digital transformation (the implementation and use of new digital technologies to enable major business improvements) as a strategic and rational process with clear roles, the most important one being a Chief digital officer or Chief digital information officer, who is often an individual appointed as a temporary position to undertake the digital transformation. This study has testified to a less rational, more emergent process, where the digital transformation happens without a Chief digital officer and instead is managed conjoint in the top management team. Based on this study, it is argued that digital transformation can be understood as distributed leadership, which enables a more holistic approach to mobilizing and sustaining digital transformation.

Keywords: Digital transformation; chief digital officer; distributed leadership; executives; organizational ethnography.

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Digitalization at the Point-of-Sale in Grocery Retail - State of the Art of Smart Shelf Technology and Application Scenarios

Marike Kellermayr-Scheucher, Laura Hörandner, Patrick Brandtner

University of Applied Sciences Upper Austria, School of Business & Management, Wehrgrabengasse 1-3, 4400 Steyr, Austria

Abstract

Digitalization has been shaping economy and society, one of the areas most affected being the retail sector. Especially in the context of smart shelf technologies a variety of companies and solutions – mainly for grocery and drugstore retail – has evolved. However, there is no overview of which technologies are used and for which specific application scenarios they can be applied. In the course of expert-interviews with solution providers, we have analysed the status-quo of different smart shelf solutions, their respective application scenarios, the technologies behind them, the associated benefits and costs as well as planned further developments. Our results show that existing solutions cover a variety of application scenarios, ranging from out-of-shelf detection and checking planogram compliance to optimizing inventory or logistical processes. Our analysis identified two main technology groups: image recognition systems and sensor-based systems. Solution providers stated that generating a positive ROI takes between one and one and a half years. All providers are working on further developments, many are moving in the direction of sensor fusion. The results of our study help retailers to compare existing solutions and enables them to examine various deployment scenarios.

Keywords: smart shelf; digitalization; retail technology, Point of sale; grocery retail.

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Diversity of Seniority in a Digital Innovation Challenge Experiment

Bjarne Rerup Schlichter[a], Ivan Juhl Nielsen[b]

[a]*Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V, Denmark*
[b]*Gavdi Labs, Sankt Jørgens Gade 3, 9000 Aalborg, Denmark*

Abstract

Many system development organizations face difficulties in ensuring innovation in digital innovation processes. This paper reports from an interpretive case study of an experiment where two system development teams compete to design a novel application. The paper explores how variation in seniority can support digital innovations and hence improve organizational learning and practice. The experiment indicates how the rules of engagement play a key role in balancing the challenge within a busy work life and provide positive outcomes in the form of hard and soft skills for individuals and for the case organization. The paper concludes by suggesting a stepwise challenge design guide and conceptual model that illustrates how the challenges concept could be included in the practitioner fields of digital innovation.

Keywords: Digital Innovation; Challenges; Learning; Information Systems.

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Enterprise Collaboration Platforms: An Empirical Study of Technology Support for Collaborative Work

Petra Schubert, Susan P. Williams

University of Koblenz, Center for Enterprise Information Research, Universitaetsstr. 1, 56070 Koblenz, Germany

Abstract

Collaboration and communication technologies are increasingly transforming work, bringing changes in the work processes and practices of individual employees and organisations. In the absence of a single technology solution to provide support for collaborative work, organisations are combining multiple systems, tools and applications to form an Enterprise Collaboration Platform that provides comprehensive support for the different forms of collaborative activities. In this paper we present the findings of a study that i) examines the complex collaborative technology landscape in order to characterise and understand the evolving portfolios of collaboration software currently in use in organisations; ii) develops a framework to visualise and analyse the assemblages of tools that are being combined to form emerging enterprise collaboration platforms. The framework is then applied to visualise and compare the emerging ECPs for two organisations and the findings are discussed in the context of the long-term management of information.

Keywords: Enterprise Collaboration Platform; Enterprise Social Software; collaborative work; tool portfolio; CSCW.

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Examining the interlink of social media use, purchase behavior, and mental health

Haslinda Hassan, Hafizah Mohamad Hsbollah, Rosli Mohamad

Tunku Puteri Intan Safinaz School of Accountancy, Universiti Utara Malaysia, 06010 Sintok, Kedah Darul Aman, Malaysia

Abstract

The widespread use of social media has created a huge market for digital marketing platforms. However, as people spend more time on social media daily, concerns about its impact on mental health have grown. Although several studies on the effects of social media on mental health have been conducted, the number of studies focusing on this issue, particularly in Malaysia, is still limited. As a result, little is known about the link between social media and purchasing behavior, as well as mental health. In order to fill this gap, the current study examines the relationships between social media use and purchase behavior, social media use and mental health, and purchase behavior and mental health. The data were collected using a quantitative method by distributing a questionnaire to social media users, particularly the X, Y, and Z generations. Data from 195 social media users were analyzed using Partial Least Squares-Structural Equation Modelling (PLS-SEM). There are significant associations between social media use and purchase behavior, as well as the impact of social media use on users' mental health. There is no evidence, however, to support the significant association between purchase behavior and users' mental health. The findings can help relevant agencies to better understand the impact of social media use on purchase behavior and mental health, and the impact of purchase behavior on mental health.

Keywords: social media use; purchase behavior; mental health; survey.

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Exploring Dataset Manipulation via Machine Learning for Botnet Traffic

Rodrigo Abrantes[a], Pedro Mestre[a,b], António Cunha[a,c]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[b]*Centro Algoritmi, Universidade do Minho, Guimarães 4800-058, Portugal*
[c]*INESC TEC – INESC Technology and Science, Porto 4200-465, Portugal*

Abstract

Botnets are responsible for some of the major malicious traffic on the Internet: DDoS attacks, Mail SPAM, brute force attacks, portscans, and others. Its dangerousness is due to the coordinated amount of infected hosts focusing on a single target. More contributions are in need, considering that (A) ML has been used for cyberattacks identification with better accuracy than standard NIDS equipments, (B) Botnet attacks are one of the most dangerous threats on the Internet. (C) the difficulties in getting representative datasets on some Botnets, and (D) Botnet traffic can be misunderstood by its infrastructure protocol.
In this paper, we focus on the identification of Botnet traffic, preventing the communication from the Botmaster to the infected hosts and consequently the Botnet cyberattacks. CICFlowMeter and Machine Learning algorithms were used to analyse Botnet2014 public dataset on four different scenarios: all Botnet traffic on a single class, each class per Botnet traffic and the influence of the IPs address fields Botnet traffic detection.
The results shows that Random Forest (RF) and Decision Tree (CART) archived similar accuracies on Botnet traffic classification. Important to say that CART obtained similar results with 10-20% of machine time. The metrics shown that the analysis per specific Botnet has higher accuracy than Any Botnet Traffic analysis. Also, the analysis with the IP addresses and L4 Ports scenario has higher accuracy but lower F1-Score that the equivalent without IP addresses or L4 Ports. At last, Feature Importance results confirms the literature, that Botnet traffic is not a single uniform protocol, but a collection of very different ways of communications between the botmaster and the infected hosts.

Keywords: CICFlowMeter, Botnet2014, Botnet Traffic, Machine Learning, Random Forest Classifier, Decision Tree Classifier.

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Factors Affecting Cloud ERP Adoption Decisions in Organizations

Vilde Christiansen, Moutaz Haddara, Marius Langseth

Kristiania University College, 7-9 Prinsensgate, 0186 Oslo, Norway

Abstract

This paper summarizes research on the adoption of cloud enterprise resource planning (ERP) systems in small and medium-size organizations (SMEs) and large enterprises (LEs) that have employed the diffusion of innovation (DOI), and the theory and technology, organization, and environment (TOE) framework. Based on a systematic literature review, this paper concludes on 13 primary factors that are the most common influencers when adopting cloud ERP at the organizational level. These factors are categorized and discussed through the DOI, and the TOE framework. The perceived relative advantage, compatibility, complexity, trialability, and observability are identified as innovation characteristics influencing the decision to adopt cloud ERP. The technological factors are identified as system quality, security, vendor lock-in, and data accessibility, while the organizational factors are identified as a financial advantage and top management support. Finally, competitive and regulatory pressures and support are environmental factors affecting the adoption decisions. Out of the 13 factors identified, vendor lock-in, relative advantage, top management support, and competitive and regulatory environment were the most common factors affecting the decision to adopt cloud ERP. Finally, this review identifies a gap related to the lack of studies in the context of LEs, and a lack of differentiation between small and medium-size organizations, which may be fulfilled by future research.

Keywords: ERP Systems; Cloud computing; Adoption; Implementation; SMEs; Les.

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Factors affecting the Adoption of Big Data as a Service in SMEs

Tayla Wessels, Osden Jokonya

University of the Western Cape, Bellville, Cape Town 7535, South Africa

Abstract

Big Data as Service (BDaaS) provides an alternative solution to overcome the challenges when a business embarks on adopting and implementing a big data strategy. Although BDaaS provides a viable alternative for SMMEs, there is limited research on the specific factors that affect the adoption of BDaaS in SMMEs. The study aims to explore the factors that affect the adoption of BDaaS in SMMEs. The study adopted the TOE framework as the lens to explore the technological, organizational, and environmental factors affecting the adoption of BDaaS in SMEs. The study results indicate that SMMEs need to consider technological, organizational, and environmental factors when adopting BDaaS. The study contributes to the body of knowledge on factors that affect the adoption of BDaaS in SMEs based on the study results. Despite the limitation of the study of not being empirical (used secondary data), the study contributes to the body of knowledge on factors affecting the adoption of BDaaS in SMEs. In addition, the study may stimulate further research on factors that affect the adoption of BDaaS in SMEs using other research methods.

Keywords: Digital Transformation; XaaS; Big Data Adoption; BDaaS Adoption; SMMEs; TOE Framework.

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Factors affecting the adoption of Data Management as a Service (DMaaS) in Small and Medium Enterprises (SMEs)

Olwethu Zide, Osden Jokonya

University of the Western Cape, Bellville, Cape Town 7535, South Africa

Abstract

The study explores factors affecting the adoption of Data Management as a Service (DMaaS) in Small and Medium Enterprises (SMEs). The study conducted a systematic literature review of published articles during the period 2008-2020 to gain insights into the factors affecting the adoption of DMaaS in SMEs. The study used a quantitative content analysis study to explore factors affecting the adoption of DMaaS. The study adopted the TOE Framework as a lens to explore the factors affecting the adoption of DMaaS in SMEs. The study revealed that the security technological factor was the most highlighted factor affecting the adoption of DMaaS in SMEs. In addition, the study indicated that the cost organizational factor was the most highlighted factor affecting the adoption of DMaaS in SMEs. Lastly, the study showed that government regulations environmental factor was the most highlighted factor affecting the adoption of DMaaS in SMEs. Despite some limitations of the study, the study contributes to the body of knowledge on factors affecting the adoption of DMaaS in SMEs. The study may also catalyze to promote further research on factors that affect the adoption of DMaaS in SMEs.

Keywords: Digital Transformation; Data Management-as-a-Service n; Everything as a Service (XaaS); Big Data; SMEs; TOE Framework.

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Failure of AI projects: understanding the critical factors

Jens Westenberger[a], Kajetan Schuler[b], Dennis Schlegel[a]

[a]Reutlingen University, Alteburgstr. 150, 72762 Reutlingen, Germany
[b]EXXETA AG, Stockholmer Platz 1, 70173 Stuttgart, Germany

Abstract

Adoption of artificial intelligence (AI) has risen sharply in recent years but many firms are not successful in realising the expected benefits or even terminate projects before completion. While there are a number of previous studies that highlight challenges in AI projects, critical factors that lead to project failure are mostly unknown. The aim of this study is therefore to identify distinct factors that are critical for failure of AI projects. To address this, interviews with experts in the field of AI from different industries are conducted and the results are analyzed using qualitative analysis methods. The results show that both, organizational and technological issues can cause project failure. Our study contributes to knowledge by reviewing previously identified challenges in terms of their criticality for project failure based on new empirical data, as well as, by identifying previously unknown factors.

Keywords: AI; Artificial Intelligence; Project Failure; Failure Factors; Success Factors; Readiness.

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Grapevine Segmentation in RGB Images using Deep Learning

Gabriel A. Carneiro[a], Rafaela Magalhães[a], Alexandre Neto[a], Joaquim J. Sousa[a,b], and António Cunha[a,b]

[a]*University of Trás-Os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[b]*INESC-TEC – INESC Technology and Science, Porto 4200-465, Portugal*

Abstract

Wine is the most important product from the Douro Region, in Portugal. Ampelographs are disappearing, and farmers need new solutions to identify grapevine varieties to ensure high-quality standards. The development of methodology capable of automatically identify grapevine are in need. In the scenario, deep learning based methods are emerging as the state-of-art in grapevines classification tasks. In previous work, we verify the deep learning models would benefit from focus classification patches in leaves images areas. Deep learning segmentation methods can be used to find grapevine leaves areas.
This paper presents a methodology to segment grapevines images automatically based on the U-net model. A private dataset was used, composed of 733 grapevines images frames extracted from 236 videos collected in a natural environment. The trained model obtained a Dice of 95.6% and an Intersection over Union of 91.6%, results that fully satisfy the need of localise grapevine leaves.

Keywords: segmentation; grapevines; deep learning.

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Ground Movement Classification Using Statistical Tests Over Persistent Scatterer Interferometry Time Series

S. Mohammad Mirmazloumi, Yismaw Wassie, José Antonio Navarro, Riccardo Palamà, Michele Crosetto, Oriol Monserrat

Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA), Av. Gauss, 7 E-08860 Castelldefels, Spain

Abstract

This study proposes modifications to an existing automatic classification method of Persistent Scatterers Interferometry (PSI) time series (TS) and a new procedure to classify ground movements into seven classes. We also represent a technique to detect TSs affected by phase unwrapping errors and a reclassification part to detect stable points, which are incorrectly classified as moving points using the original method. Around 60 km^2 of Catalunya were classified using Sentinel-1 images and a PSI technique. The proposed method classified 78359 PS TS. This study provided the spatial distribution of ground movement classes and detected several time series anomalies.

Keywords: DInSAR; GMS; PSI; Classification; Sentinel; Remote Sensing

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How Digital Tools Align with Organizational Agility and Strengthen Digital Innovation in Automotive Startups

Dulce Gonçalves[a], Magnus Bergquist[a], Sverker Alänge[b], Richard Bunk[a]

[a]Halmstad University, Kristian IV:s väg 3, 301 18 Halmstad, Sweden
[b]IMIT, 412 96 Gothenburg, Sweden

Abstract

Digital tools can be an enabler for automotive startups to strengthen their digital innovation capability. Still, few empirical studies describe how automotive startups apply digital tools to do this. Digital innovation capability is essential for survival in a volatile global digital marketplace. Therefore, we conducted a qualitative study based on 23 interviews with nine global automotive startups to understand how they apply digital tools to strengthen their digital innovation. The results showed that automotive startups use cloud services almost exclusively for their business. We conclude that startups choose to use digital tools as SaaS to strengthen their organizational agility and digital innovation initiatives. It harmonizes with their agile culture, effectively enabling innovation collaborations between employees internally and with external actors enabling rapidness to market. SaaS providers' startup programs enabled startups to remain focused on their innovation initiatives and not worry about scalability since the solutions scaled from the start.

Keywords: Digital Tools, Organizational Agility, Digital Innovation Capability, Agile Culture, Automotive Startups

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Identifying Sales-Influencing Touchpoints along the Omnichannel Customer Journey

Robert Zimmermann, Wolfgang Weitzl, Andreas Auinger

University of Applied Sciences Upper Austria, Wehrgrabengasse 1-3, Steyr 4400, Austria

Abstract

Retailers have started to integrate their online and offline channels in order to increase revenue by creating a superior customer experience. However, they lack an instrument with which to identify the touchpoints that are most influential for customer decision making. Therefore, this study introduces a novel, multi-method approach that utilizes combined data-collection and data-analyses procedures that help retailers to identify and meaningfully cluster relevant touchpoints along the customer journey. Results indicate, among others, that retailers can benefit from abandoning the classic, within-company perspective and cluster their touchpoints according to the customers' perspective. Furthermore, our approach enables retailers to infer the most important sales-influencing touchpoints. Here, findings indicate that retailers should be selective in providing the right touchpoints for their customers, as some of them can have a direct or indirect negative impact on sales. Retailers can use these insights to support their touchpoint-selection and thus decision-making process through thought provoking impulses.

Keywords: Omnichannel; Touchpoints; Customer Journey, Sales.

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Improvement of planning and time control in the project management of a metalworking industry - case study

José Silva[a], Paulo Ávila[a,b], Leonel Patrício[a], José Carlos Sá[a], Luís Pinto Ferreira[a,b], João Bastos[a,b], Hélio Castro[a,b]

[a]School of Engineering (ISEP) - Polytechnic of Porto, 4200-465, Porto, Portugal
[b]INESC TEC, 4200-465, Porto, Portugal

Abstract

Due to the competitiveness in the job shop nature of the metalworking industry, project management plays an important role in improving performance, efficiently and effectively managing its performance. Many of the generic problems observed in project management in metalworking industries were in the domain of document management, communication, multiple projects simultaneously, organizational structure, and poorly time estimation of project activities. The aim of this study was to improve the planning and time control in the project management of a metalworking industry in order to reduce the delivery delays. Using the existing data, an analysis of the project management process was carried out with the view to optimize the production system. In order to meet the established objectives, some of the project management tools were used, such as the Ishikawa diagram, PERT (three points estimating times), Monte Carlo simulation, as well as the involvement of people in the estimation and sequencing of activities, and holding weekly meetings to ensure the alignment of professionals. After the implementation of the actions proposed for the production process, there were gains of 50% and 38% in the average of deviations of times for two different projects of the case study and the Monte Carlo gave the best approximation.

Keywords: Planning Methodologies; Project management; PERT; CPM; Planning and control, Monte Carlo.

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IT architects and IT-business alignment: a theoretical review

Christof Gellweiler

WHU – Otto Beisheim School of Management, Burgplatz 2, 56179 Vallendar, Germany

Abstract

The strategic significance of IT architecture has been recognized for decades. However, the roles of IT architects and their importance to IT-business alignment are still underrated in theory and practice. This article provides a literature review, classifies the roles of IT architects, and describes their influence on IT-business alignment. The main aims of IT architects are effective and efficient selection and integration of IT components/services to meet the business requirements by providing guidance and standards. Eight types of IT architects were found that perform at the strategy/business level and the project/solution level. Enterprise architects are essential for achieving IT-business alignment; they can shape an organization's IT landscape towards business flexibility or standardization in order to differentiate on the market or lead on costs.

Keywords: IT-business alignment; Business-IT alignment; enterprise architecture; IT architecture; architects.

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Lean 4.0 tools and technologies to improve companies' maturity level: the COVID-19 context

Elafri Najwa[a],Rose Bertrand[b], Maleh Yassine[c], Gabriela Fernandes[d], Majed Abdeen[e], Sassi Souad[a]

[a]*University of Constantine 3 salah boubnider, Department of project management,AVMF laboratory, Constantine,Algeria*
[b]*University of Strasbourg, Icube laboratory, Strasbourg, France*
[c]*USMS University, cLaboratory laSTI, ENSAK, Beni Mellal, Morocco*
[d]*University of Coimbra, CEMMPRE, Department of Mechanical Engineering, Polo II, Coimbra, 3030-788, Portugal*
[e]*University of Liverpool, Liverpool, United Kingdom*

Abstract

The global pandemic triggered by the new COVID-19 led to severe limitations in daily life, both private and professional. Almost all companies have been affected in one way or another. The COVID-19 crisis imposed new challenges for enterprises. As a result, many companies have been forced to rethink how to align many of their processes and practices with the new COVID-19 context, and fulfill their mission while maintaining a safe and secure management business operating environment for both employees and customers. This paper aims to bring empirical evidence, through a questionnaire survey, of the positive influence of using Lean Management tools and Industry 4.0 technologies on five organizational dimensions (strategy, leadership, culture, operations and products, and technology). Data from 98 Algerian and French companies of different sizes and representing various activity sectors was collected. Respondents were asked to answer 5 organizational dimensions (strategy, leadership, culture, operations and products, and technology) in the context COVID-19 crisis. Statistical analysis was performed through path coefficient using a Smart PLS. The results show that Industry 4.0 technologies tend to be strongly associated with Lean management tools, and that understanding the relationship between Lean management tools and Industry 4.0 technologies can improve the organizational dimensions: leadership, strategy, operation, and production.

Keywords: Lean 4.0; Tools and technologies; Organizational dimensions; COVID-19 crisis.

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Methodology for Introducing Creativity in Requirements Engineering

Vitor Santos[a], Henrique Mamede[b], Clara Silveira[c], Leonilde Reis[d]

[a] *NOVA Information Management School, Universidade Nova de Lisboa, Lisboa, Portugal*
[b] *INESC TEC, Departamento de Ciências e Tecnologia, Universidade Aberta, Lisboa, Portugal*
[c] *Escola Superior de Tecnologia e Gestão. Instituto Politécnico da Guarda, Guarda, Portugal*
[d] *Escola Superior de Ciências Empresariais, Instituto Politécnico de Setúbal, Setúbal, Portugal*

Abstract

The increase of global competitiveness, the ability of organizations to effectively use information technologies, and to focus on innovation and creativity are recognized as being important. In this context, the hypothesis of resorting to known creativity techniques or adaptations to help innovation in the field of Software Engineering appears to be challenging. This paper proposes a methodology for introducing creativity and innovation techniques in the Requirements Engineering process in order to build more agile and efficient Information Systems. The method uses a variety of creative techniques that are thought to be appropriate to the different stages of the process and is inspired by existing creative problem-solving methods and techniques, in particular in the Creative Problem-Solving Process, Productive Thinking Model and the Creative Potentiation Method. The study of the method allowed its application, through the use of various creativity techniques, in a real context in a social institution - the Social Center for Support to the Community of São Domingos. The application of the methodology allowed the identification of new opportunities that allowed the organization to devise service delivery strategies that were more suited to the needs of people.

Keywords: Requirements Engineering; Creative Thinking; Creativity Techniques; Sustainability.

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NoOps – A Multivocal literature review

Tommy Stefanac, Ricardo Colomo-Palacios

Østfold University College, B R A Veien 4, Halden 1783, Norway

Abstract

Traditionally, an organization had to have in-house servers and hardware to build a web application. This evolved into Cloud computing where the possibility for cost reduction and scalable data storage became a reality. With the introduction of cloud computing came a concept known as NoOps, or No Operations. This paper aims to take a closer look into what NoOps is and the benefits and challenges of NoOps. The authors identified three RQs that could help to give more insight into NoOps. Further we discussed the findings and RQs and lay out the way forward for future studies into NoOps. We also looked at artificial intelligence (AI) and how AI seems to be heavily linked with a true NoOps environment. With the lack of scientific studies into NoOps, a Multivocal literature review was selected as the method used to investigate the concept and its implications. We try to show voices both for and against NoOps. Further, we try to look at a misconception of what NoOps really is, what true NoOps could be. Finally, we look at what requirements there are for companies wanting to go NoOps, and discuss the possibility that many companies unknowingly are moving towards a NoOps environment.

Keywords: NoOps; Cloud computing; Serverless; AI; Artificial intelligence; Evolution IT.

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Online grocery shoppers due to the Covid-19 pandemic - An analysis of demographic and household characteristics

Niklas Eriksson, Minna Stenius

Arcada University of Applied Sciences, Jan-Magnus Janssonin aukio 1, 00560 Helsinki, Finland

Abstract

As a result of the Covid-19 pandemic, consumers in many countries have increasingly adopted online grocery shopping. This study aims to investigate the demographic and household characteristics of these adopters, by analyzing the data from a large-scale survey (n=2568) in Finland. The results indicate that a typical adopter of online grocery shopping due to Covid-19 is less than 45 years old, and one with some concern over own health or that of a loved one. The more likely adopters also have a higher household size, higher household earnings, and/or they are more likely to live in the capital region of the country. Further, the results indicate that in the older age group (45+), women and those with some degree of worry over own health and/or that of a loved one are a little more likely to be adopters than the rest.

Keywords: online grocery shopping; eCommerce; innovation adoption; consumer behavior; Covid-19.

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Potential of automated configuration control to reduce hospital building deficiencies

Pia Schönbeck,Malin Löfsjögård, Anders Ansell

KTH Royal Institute of Technology, Department of Civil and Architectural Engineering, 100 44 Stockholm

Abstract

The configuration of healthcare buildings is complex, especially emergency hospitals that require many functions. In this study, the aim was to explore if automated configuration control can reduce occurrences of hospital deficiencies in construction projects. A bow-tie risk analysis identified the causes and consequences of configuration deficiencies. Measures to prevent and recover from deficiencies were established from configuration management research. Three newly built emergency hospitals were studied to investigate to what extent causes, consequences, preventive and recovery measures were present. The most common causes of deficiencies were deviations from intended configurations, in the literature and the cases. The consequences were cost increase, time delays, insufficient deliveries and corrective rework. None of the examined cases had implemented preventive or recovery measures associated with configuration control. Altogether, these results indicate that automation of configuration control may effectively reduce hospital building deficiencies and subsequent effects.

Keywords: Information management; Configuration management; Automation; Digital transformation; Healthcare buildings.

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Sustainable Criteria to the self-decision making of the partners regarding its integration in collaborative networks

Leonel Patrício[a], Paulo Ávila[b,c], Leonilde Varela[a,d], Carlos Costa[a,f], Paula Ferreira[a,d], Maria Manuela Cruz-Cunha[e], Luís Pinto Ferreira[b], João Bastos[b,c], Hélio Castro[b,c]

[a]*Universidade do Minho, Department of Production and Systems Engineering, 4800-058 Guimarães, Portugal*
[b]*School of Engineering (ISEP) - Polytechnic of Porto, 4200-465, Porto, Portugal*
[c]*INESC TEC, 4200-465, Porto, Portugal*
[d]*ALGORITMI Research Centre, Universidade do Minho, 4800-058 Guimarães, Portugal*
[e]*2Ai - Applied Artificial Intelligence Laboratory, Polytechnic Institute of Cávado and Ave, Portugal*
[f]*Federal Institut of Minas Gerais (IFMG) -Bambuí, Brasil*

Abstract

There are several works and research related to the formation of Collaborative Networks (CN). The participation of an Organization in a Collaborative Network is a theme of broad spectrum and of great interest in research, although it appears that it continues to be far from being fully explored. The objective of this work is centred on the identification of the critical success factors (CSF) that can serve as a basis for reaching a suitable model that assesses whether the participation of an Organization in a CN brings sustainability gains. This work analyses some models or studies available in the literature and identifies important CSF. The Triple Bottom Line (TBL), related to environmental, social, and economic effects is considered to guide the selection and categorization of these CSF. Regarding the results obtained, it appears that there is still large room for improving the research in this field, for instance, regarding further development of a robust and flexible evaluation model based on the identified CSF taking into account the TBL of the sustainability concept for each Organization considering its participation in a CN.

Keywords: Collaborative Network; Assess participation; Critical success factors; Pillars sustainability.

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The effect of Electronic Health Records on the medical professional identity of physicians: a systematic literature review

Albert Boonstra, Janita Vos, Lars Rosenberg

University of Groningen, Faculty of Economics and Business, Nettelbosje 2, 9747 AE Groningen, The Netherlands

Abstract

Electronic Health Records (EHR) have become standard practice and have altered the way physicians work and communicate with their patients. This changing work environment may subsequently influence the perceived professional identity of physicians. In this study, we aim to understand the impact of EHR use on the medical professional identity of physicians. We conducted a systematic literature review which resulted in the analysis of 34 papers that met inclusion quality criteria. The literature suggests that EHRs make the interaction between patients and physicians more formal and standardized. In addition, physicians experience a decrease in their autonomy which negatively influences their experienced professional identity. Based on these findings, we recommend examining how EHRs can allow physicians to focus more on medical work and communication with their patients and be less distracted by EHR requirements so that their medical professional identity can be restored or enhanced.

Keywords: Electronic Health Record; professional identity; work design; communication.

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The influence of technological innovations on international business strategy before and during COVID-19 pandemic

Carla Santos Pereira[a], Bruno Veloso[b], Natércia Durão[a], Fernando Moreira[a,c]

[a]*University Portucalense & REMIT & IJP*
[b]*University Portucalense & INESCTEC*
[c]*IEETA – University of Aveiro*

Abstract

In the last two years, the world has gone through an unprecedented change in the most diverse dimensions (social, economic, and even political), leading that society had to adapt very quickly to the contingencies imposed by COVID-19. All organizations (independent of their area of activity) had to adjust their processes to respond, efficiently and effectively, to these constraints. In this context, companies with concerns in internationalization (those that are already internationalized and those in an internationalization process) have had to resort to technologies to support the change in their *modus operandi*. The digital transformation (until now had an essential role in the transformation of organizations, but which was in a relatively slow implementation process) started to perform, in an accelerated way, the base of work for the heads of the organizations to be able to respond to these challenges. In this context, the transformation of the business model, supported by digital technology, has been documented as one of the strategies used to respond to disruptive environmental changes, particularly technologies that help companies identify new business practices. This study aims to find evidence of the importance of integrating and influencing technological innovations in the practice of international business strategy before and during COVID-19 pandemic. The results show the influence of the digitalization on the business strategies.

Keywords: technological innovations; international business; COVID-19 pandemic; digital transformation.

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Towards a Pay-Per-X Maturity Model for Equipment Manufacturing Companies

Joonas Schroderus[a], Lester Allan Lasrado[b], Karan Menon[a], Hannu Kärkkäinen[a]

[a]*Faculty of Management and Business, Tampere University, Korkeakoulunkatu 7 Kampusareena, 33720 Tampere, Finland*
[b]*School of Economics, Innovation and Technology, Kristiania University College, Prinsens gate 7-9, 0107 Oslo, Norway*

Abstract

This Research-in-Progress paper presents a preliminary design of a maturity model for assessing the internal readiness of business-to-business equipment manufacturing companies implementing new, service-based pay-per-x (PPX) business models. By using existing maturity model design guidelines, action design research methodology as well as PPX-related literature and analogous maturity models in fields such as servitization, digitization, Industry 4.0, data-driven manufacturing and product-service systems, this paper explains how the creation of a maturity model could enable a systematic approach to implementing the new PPX business models. The paper will also provide the basis for the PPX maturity model development and validation in the future, while aiding the equipment manufacturing companies in assessing their current as-is situation in the most critical areas of PPX implementation as well as formulating a roadmap towards the implementation.

Keywords: Pay-per-use, PPX, Maturity Models, Business Models, Value Creation.

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Using a graph database for the ontology-based information integration of business objects from heterogenous Business Information Systems

Carolin Blankenberg, Berit Gebel-Sauer, Petra Schubert

University of Koblenz, Center for Enterprise Information Research, Universitaetsstr. 1, 56070 Koblenz, Germany

Abstract

This paper reports on findings from a project on *information integration* from *multiple* Business Information Systems with the help of a *user-specific Enterprise Knowledge Graph*. Most ERP systems currently in use store information objects in relational databases. Research in Web Sciences has shown that *graph structures* present information in a *more intuitive way* that is easier to interpret for humans. Following a DSR approach, we developed a concept for storing an ontology in a graph database that allows us to map ERP objects and load them at runtime. This allows the end user to navigate through the graph structure, thus providing an intuitive and quick access to essential job-related information. We evaluated the suggested concept with a prototype following the paradigm of polyglot persistence; the prototype was equipped with a graph database to store the company-specific ontology in its native form. The program code was encapsulated into a separate module following a service-oriented software design.

Keywords: IS Integration; Enterprise Knowledge Graph; Ontology; Graph Database.

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Band reduction in hyperspectral imaging of Flavescence Dorée grapevine disease by polynomial approach

Roshan Nepaul[a], Théo Bernardin[a], Kevin Fanton[a], Joaquim J. Sousa[b,c,*] António Cunha[b,c]

[a]*Polytech Annecy-Chambéry, 2 Av. du Lac d'Annecy, 73370 Le Bourget-du-Lac, France*
[b]*Universidade de Trás-os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[c]*INESC TEC – INESC Technology and Science, Porto, 4200-465, Portugal*

Abstract

Sustainability of all wine production is threatened by several diseases, including Flavescence dorée, that causes considerable crop losses, sometimes irreparable. This disease is characterized by the appearance of a reddish coloration in grapevines leaves. Hyperspectral imaging is widely used today, particularly in the field of agriculture. Indeed, unlike RGB images for example, spectral imaging presents a continuous spectrum, which allows it to recover information in the ultraviolet and infrared range in addition to the visible range. We used a hyperspectral sensor to take pictures of these vine leaves that acquires image with 272 bands. The problem with these 272 bands is that although they offer a wide range of important information, they also make the storage, processing, and computing time very heavy. Indeed, by using deep learning models to predict whether leaves are infected or not, this considerably increases the computation time. In this paper, we propose a methodology to reduce the number of bands, while retaining the essential information for the detection of Flavescence Dorée disease. We use a polynomial to approximate the hyperspectral function of each pixel of the hyperspectral image. We achieve an average error smaller than 1 percent, that encourage us to proceed with more advanced experiments.

* Corresponding author.
E-mail address: jjsousa@utad.pt.

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Keywords: Bands reduction; Approximation; Hyperspectral images; Polynomial; Diseases.

1. Introduction

Today, the sustainability of all wine production is threatened by Flavescence Dorée (vine disease) that causes considerable crop losses. It is therefore necessary to be able to detect the presence of this disease as early as possible, so that it can be treated, and its spread prevented [1]. Currently, to detect the presence of this disease, winegrowers call in experts that search vine by vine to see if the plant or part of the plant could show signs of infection. However, this work remains tedious and relies only on the human eye, which is a problem since sometimes healthy plants are torn out, while diseased ones are left. A different approach to the one that exists today is needed to make this process automatic to have better results in terms of time consumption and economic resources. In our research, we use hyperspectral images [2] which, unlike RGB images, have a continuous spectrum that contains more information than the human eye can see. In addition, hyperspectral sensors are often used in agricultural image analysis.

We used data from the Nano-Hyperspec sensor (uVS-320) with a frame period of 15ms, an exposure of 15 ms, in a spectral range between 400 and 1000 nm, dividing it into 272 different bands. Therefore, due to the number of bands obtained, each image contains a large amount of information which makes it very heavy, in consequence it requires a lot of storage and time to process it. Thus, to train our deep learning models to detect from hyperspectral images whether they are infected or not, we need to reduce this number of bands, to be more efficient in learning, while keeping the important information from each image. The aim of this paper is to investigate how to reduce the number of bands in hyperspectral images, while retaining the essential information for the detection of Flavescence Dorée disease. We propose an approach consisting in approximating the hyperspectral function of each pixel of the hyperspectral image (the reflectance of the pixels of every band). At the end, our goal is to generalize a function representing the spectral signature of leaves labeled as normal and generalize another one for the leaves labeled as infected.

2. Methodology and results

To complete this research project successfully, we started by studying the spectral signatures of the leaves. To do this, we applied a mask to the root of the leaf because this is where the disease starts to spread. Then we selected 180 pixels on average in this area at random and calculated the average spectral signature of these 180 pixels. We did this for both infected and uninfected leaves. This gave us a specific spectral signature representative of the infected leaves, and the same for the uninfected leaves. Each pixel is composed of 272 bands. Thus, when we represent the spectral signature, we obtain a scatter plot

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composed of 272 points corresponding to the reflectance of each band as a function of wavelength. The aim of this approach is to be able to draw a function for the uninfected leaves that is representative of their spectral signature, and similarly for the infected ones. Thus, the 272 bands could be reduced to the number of parameters that characterize the function (the degree of the function if it is polynomial for instance). Indeed, to date, several approximation methods exist, such as the Lagrange interpolator polynomial to name but one. However, most of these methods already use a basis function and then try to approximate it in different ways. As we did not have a basis function representative of this spectral signature, we had to find a method to approximate this signature, while minimizing the error, to design a function that can fit the available data. To do this, we used a Vandermonde matrix [3]. Thus, we used the polyfit function of MATLAB [4]. We therefore obtain two different approximate curves, one for the infected and one for the uninfected as shown in (Figure. 1)

To obtain this approximation, we selected our 7 infected leaves, calculated their average spectral signature, and the same for the 24 non-infected leaves. We then used our method to approximate our signature. We finally managed to find an approximation by a polynomial of degree 18 for our entire scatter plot, and this for the polynomial of infected and non-infected leaves. We calculated the relative error. We compared the distance between our initial curve and our approximated curve using our function, and we are on average within 1% of this approximation. However, as we are working with high and low frequencies, this influences the shape of the curve, especially at the extremities (noise can be seen), which is an encouraging result. It would therefore be necessary, in a second step, to remove these extremities which do not provide any more information. Thus, we could further reduce the number of bands by reducing the degree of our polynomial. We used this method because as we had no starting function to approximate but only a point cloud, it was the best approach.

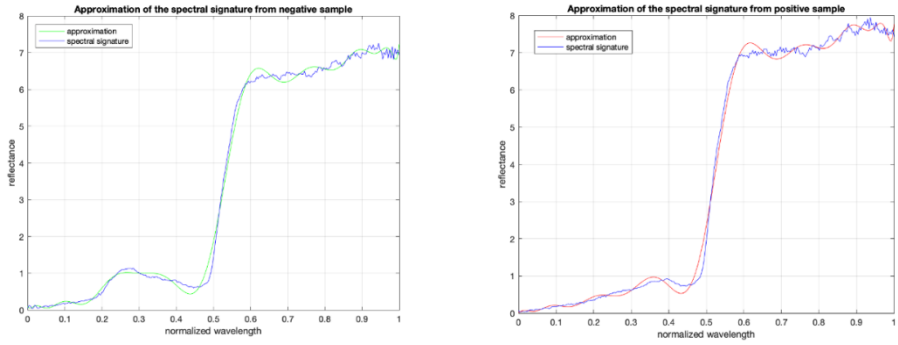

Figure 1 (a) The spectral signature of uninfected leaves in blue and the approximate function in green (b) The spectral signature of infected leaves in blue and the approximated function in red.

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1. Conclusion

In conclusion of this paper, we can observe that this first approach of band reduction using a polynomial presents some results. Indeed, our spectral signature which was composed of 272 bands is now reduced to 18 parameters. However, this is only one approach among many others related to polynomial. We can indeed segment our signature, to obtain more distinct parts, and approximate these parts in different ways. We managed to achieve an approximation with less than 1% error, which is a good result for a first approximation. This encourages us to continue our research in this direction and to continue improving our work. By reducing the number of bands, this allows us to keep the important information to use the images for analysis, whether for classification, clustering, or prediction. In addition to the wine industry, this could obviously be adapted to all fields using hyperspectral imagery

Acknowledgements

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Characterization of seaweed communities using deep learning applied to UAV-based hyperspectral images

João Pedro Gomes[a], Joaquim J. Sousa[b,c]*, Luís Pádua[b], Carlos R. Cunha[d], António Cunha[b,c]

[a]*Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal*
[b]*Universidade de Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal*
[c]*Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência,Porto 4200-465, Portugal*
[d]*UNIAG, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal*

Abstract

Macroalgal communities provide shelter and food for many organisms and are of interest to the food industry, pharmaceutical, and agriculture. They are also an indicator of environmental change. The use of unmanned aerial vehicles (UAVs) allows the remote collection of images with high spatial and spectral resolution and adjustable time scales. The development of methodologies allowing the processing and the analysis of UAV-based high-resolution imagery would be of economic and environmental importance. That would allow to streamline the identification of species with economic potential, the evaluation of the seasonal and spatial variation of the available biomass, and the monitoring of the coastal ecological status and its evolution. Hyperspectral sensors can nowadays be coupled in UAVs allowing for high spatial and spectral resolution imagery. The data processing powered by deep learning and its increasing diversity of models and architectures is the ideal way to handle and analyze the huge volume of data acquired. In this paper, we present a methodology to make the automatic classification of existing species in macroalgal communities, using deep learning models applied to hyperspectral images collected by UAVs.

Keywords: Seaweed; Macroalgae; Hyperspectral; UAV; Deep learning; Machine Learning.

* Corresponding author.
E-mail address: jjsousa@utad.pt.

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1. Introduction

Seaweeds or macroalgae have significant environmental and ecological importance and economic interest.

Several studies have been carried out to explore their use in many different areas, such as cosmetics [1], livestock diet [2], horticulture [3], medicinal and pharmaceutic [4], or energy [5].

Ecologically, seaweed communities are fundamentals in coastal habitats, being "important primary producers, competitors, and ecosystem engineers" [6], sustaining most temperate coastal ecosystems and providing food and shelter for many associated species, both animals and plants [7]. They are also used as biological indicators to monitor ecosystem health [8].

The mapping and measuring of the seaweed's communities have been done through different approaches. Lately, the use of UAVs has enabled the remote collection of images with high spatial resolution and with adjustable time scales, accessible, and at a controlled cost [9]. The potential of a UAV coupled with a hyperspectral sensor for mapping macroalgal habitats had been demonstrated [10]. It will enable the construction of reflectance profiles of the various species of seaweeds with greater discrimination, facilitating the process of classification. Finally, we believe that machine learning and, particularly, deep learning (DL), with all the recent advances in its models and algorithms, may assist in the automatic image classification process and in getting ecological descriptors and indices.

As such, we aim to develop a system to automatically classify existing species in seaweed communities in intertidal zones and estimate their biomass, using deep learning models applied to hyperspectral images collected by UAVs.

2. Methodology

Figure 1 illustrates the approach taken to address the problem of identifying different types of algae applying DL to hyperspectral UAV-based imagery. After the initial phase of data collection, data will be subjected to various correction and processing techniques. The resulting data will then feed the learning models that will produce the desired results, that is, the classification of seaweeds and the estimation of their biomass.

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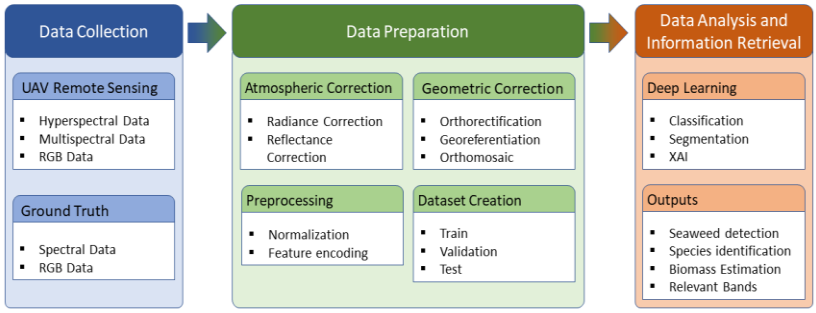

Fig. 1. Methodology phases.

Data collection is done using a UAV equipped with RGB, multispectral, and hyperspectral sensors. The surveys are done over rocky intertidal areas, at different seasons, to allow measure the evolution of seaweed communities, both in terms of their physiological state and the occupied area.

The raw data obtained goes through a process of preparation and transformation, so that they can be reliably used by the ML algorithms. This includes the correction of radiometric and geometric errors resulting from remote sensing, orthomosaic creation, preprocessing, and dataset creation. Ground-truth georeferenced points are implemented in each survey. Each of them is photographed, spectral data is collected, the existing seaweed is identified, and their biomass quantified. This data will then be used in the supervised learning system and for validation of the results.

For data analysis, we intend to explore some deep learning algorithms and models, to assess the ones providing the best results in obtaining the desired outcomes: (1) Identification of the relevant spectral bands for the classification of seaweeds (dimensionality reduction); (2)Seaweed detection and determination of the occupied area; (3) Seaweed species classification; (4)Seaweed biomass regression.

Explainable artificial intelligence (XAI) methods will be combined with DL models used in the seaweed classification, to provide insight into the most sensitive wavelengths in that process. To support the decisions to be taken about the DL algorithms to be used, a comprehensive survey is being carried out on this topic and the technologies involved.

2. Conclusion

Seaweed is the largest group of algae, playing an important role in the marine ecosystem, with great environmental importance, and of economic interest. The possibility of monitoring them promptly, periodically, and in large areas, would be useful, as they are a recognized indicator of ecological status.

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We believe that the presented approach will be able to make a meaningful contribution to this topic, developing a solution that allows the detection of the area occupied by seaweed communities, the identification of the species they are constituted by, and the determination of their biomass. To this end, we intend to take advantage of recent technological developments, using deep learning algorithms applied to high-resolution UAV-based hyperspectral imagery.

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Deployment of Enterprise Architecture for Management of Digital Services in Smart Cities

Bokolo Anthony Jnr.*, Sobah Abbas Petersen, Eldar Hauge Torkelsen

Department of Computer Science, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

Abstract

Over the years Enterprise Architecture (EA) has become an intensively researched and applied approach aimed at managing transformation of cities into smart cities. Thus, most cities are deploying EA as an approach to manage enterprise's implementation of Information Technology (IT). While many cities deploy EA, there are initiatives that impacts the value that can be derived when EA is deployed for management of digital services in smart cities. Therefore, this article explores the current practice of EA by practitioners and stakeholders involved in smart city project through qualitative data via survey research method. Findings from this study discuss the importance of EA and provides practical insights on EA deployment in smart cities. Thus, enabling municipalities to focus and better plan on how to anticipate and prepare for digital change during smart city development. Besides, the findings provide IT managers, enterprise architect, and urban planners with evidence of how EA can facilitate implementation of digital services in smart cities.

Keywords: Information systems; Enterprise architecture deployment; Practitioners; Digital services; Smart cities; qualitative data

* Corresponding author. Tel.: +47-41398239; fax: +47-41398239.
E-mail address: anthony.j.bokolo@ntnu.no

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1. Introduction

Over the decade there is increased research on Enterprise Architecture (EA) deployment among academia and industry [1]. EA aims to achieve goal-oriented coherent and organizational structures, processes, information provision, and technology management. EA describes the essential structure of an organization and supports institutional transformation by providing a holistic view on as-is as well as to-be processes and structures. EA is the representation of the behavior and structure of an enterprise's business environment in relation to its IT landscape. It depicts the current and future deployment of IT in the enterprise and specifies a roadmap to attain future state [2]. EA also enhances strategies and provides informed business, operations, and IT decision that enhances institutions to accomplish their objectives [3]. EA underpins managerial decisions relating to applications, data, human infrastructure and technical infrastructure, and management responsibilities [4].

Also, existing literature on EA deployment are concerned into how enterprises sustain their EA strategies [2]. In urban context an effective EA is vital to smart city`s survival and success [1]. The deployment of EA has some significant strategic value for cities, such as strategic agility and better operational management. But irrespective of the benefits to be attained, EA is not widely adopted when cities want to implement digital services to citizens. This may be due to difficulties or issues faced in deploying EA in smart cities [5]. Nonetheless, while extant studies have researched on the potential, costs, and benefits of EA, the practice of EA particularly in smart cities has not been empirically explored [6]. Furthermore, it remains challenging for practitioners to effectively deploy EA in their urban process [7]. Thus, there is still a call for research on how EA is deployed in the public sector specifically in urban context [3]. This article aims at providing knowledge on the practice of EA deployment from smart city perspective. To be more specific, this study seeking an answer to the research question:

- What is the current practice of enterprise architecture in smart city domain?

Hence this current study carries out a research grounded on qualitative data via survey research method to provide practical empirical evidence on issues faced when EA is employed by practitioners involved in making cities smarter. This article is arranged as follows: In the next section, the theoretical background is described. In section 3 the research methodology adopted is discussed. Section 4 is the results. Section 5 is the discussion and implications of study. Finally, the conclusion, limitations, and future works are presented in section 6.

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2. Theoretical Background

This section presents on overview of smart cities, the role of EA in smart cities, and related works that employed EA in public and private sectors similar to this current study.

2.1. Overview of Smart Cities

A smart city is a city that employs smartness in its governance, living, economy, mobility, people, and environment towards improvement of its citizens and stakeholders [8]. Smart city deploys Information and Communication Technology (ICT) in several areas within the city such as in transportation, health, services, and facilities to improve the economic, social, environmental, and technological aspect of the city [9]. Accordingly, deployment of ICT is becoming a tool for the digital transformation of cities into smart cities. Thus, ICT directly and indirectly leads to smart city development by improving the lives of residents, enhancing innovation growth, increasing resource efficiency, and generating new jobs [8]. Researchers such as Sobczak [8] argued that smart cities should not be conceptualized only based on their physical structure but should be seem like a huge network of digitally and seamlessly connected systems of systems. Smart cities enable the optimization of urban's resource use and the decrease of negative rebound effects that impacts proper functioning of the city in connection to the goals of sustainable development [10]. Smart cities aimed to safeguard and preserve the natural environment while utilizing its resources to address present needs of the society [8]; [9].

2.2. Role of Enterprise Architecture in Smart Cities

EA provides a formal description of the present and possible future state(s) of a city, and a managed transformation roadmap between these states to meet citizens and other stakeholders' goals thus creating value to the city [5]. EA comprises of models, principals, and methods that are employed in the design and actualization of an institution's structure, technologies, business processes, and information systems [11]. EA deployment facilitates a flexible and stable environment, leading to digital innovation and transformation consequently supporting enterprise flexibility and stability [4].

Additionally, EA deployment enables enterprises to decrease IT business alignment risks, improved flexibility for enterprises that provide digital services by accelerating digital innovation, bridging gaps between business and IT, and enabling appropriate business and environmental changes [12]. In urban context, EA is mostly adopted as a method to manage digital transformations of cities [1]; [13], towards fostering business and IT alignment. EA provides communication and documentation of the current enterprise processes/structures, support for the deployment of to-be processes/structures, and support for city transformation into future structures/processes [14].

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2.3. Related Work on Enterprise Architecture in Public and Private Sectors

Over the decades, several studies have employed EA to achieve competitive advantage in organizations. Among these studies Al-Kharusi et al. [11] examined stakeholders and enterprise architects towards an alignment framework for EA development. The authors designed an alignment framework to support EA development procedure with the stakeholders to achieve an architecture to provide guidance grounded on qualitative case study and data collected from 15 interviews conducted with the stakeholders and architects. Kotusev and Kurnia [15] conducted a comprehensive review and taxonomy of theoretical foundation of EA. The researchers provided a critical understanding of EA practice. Their study provided theoretical insights on EA research and contributed to the development of a theoretical basis for EA discipline.

Mirsalari and Ranjbarfard [2] developed a model for evaluation of EA quality. The purpose of the study aimed to specify EA quality attributes and its evaluation metrics within organizations. The model helps organizations to assess the quality of the deployed EA or as-is status of EA and provides the phase required to improve the current practice. Anthony Jnr et al. [16] employed Application Programming Interface (API) to examine big data management to achieve sustainable energy prosumption services in smart cities based on a developed EA framework.

Weiss and Winter [17] developed a measurement items for the institutionalization of EA management in enterprises. The research contributed to assess and inform EA management design from several, moderately new perspectives. Aier et al. [14] presented a classification of EA scenarios based on an exploratory analysis. The study presented three different EA scenarios and further provided the foundation for situational EA approach engineering.

Van Der Raadt et al. [18] investigated stakeholder perception towards EA. The authors aimed at achieving organizational goal and collaboration between EA stakeholders and architects. Arbab et al. [19] explored the integrating architectural models symbolic, subjective models, and semantic in EA. The study made a difference between 3 classes of models. Findings from the reviewed seven studies suggest that the main contributions in EA are mostly grounded on secondary data and studies that empirically report on current EA initiatives being deployed in organizational context, but studies on urban context are limited [20]. Therefore, there is need for research that offers qualitative evidence linking EA application to smart city development.

3. Methods

This study employs qualitative and interpretive research method using semi-structured interview to collect data similar to prior study [21] via survey employed as the research method based on purposive sampling of respondents from 18 organizations in Norway and Ireland involved in the smart city project +CityxChange (https://cityxchange.eu/) where an EA framework was developed as presented in [22].

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Qualitative method is adopted in this study as it provides an in-depth understanding about the phenomena that is being explored such as the deployment of EA for management of digital services in smart cities. The data collection took place between November 2020 to January 2021 by the means of the online survey questionnaire. Invitations were sent in November 2020 and in January 2021 additionally reminder was sent to participants to partake in the survey. The request to partake and provide data was sent to 40 prospective participants involved in the in the smart city project +CityxChange. The first part of the data collection instrument prompt a question to (*Consent for participation in the study: I have received and understood information about the project to provide feedback on Enterprise Architecture Framework*), request for the consent of the respondents to participate in providing data stating that their participation is voluntary. After sending the request 2 consecutive times only 13 participants responded to the invitation to provide data as regards to quantitative and qualitative questions. But only the qualitative questions are reported in this study as shown in Table 1. The data helps towards the validation of the EA framework that was developed in the +CityxChange project [22], which comprises of seven layers (context, service, business, application and data processing, data space, technologies, and physical infrastructures), and perspectives (stakeholder and data).

The collected qualitative data was analyzed using descriptive and narrative analysis and the data provided by the participants were clustered based on their reply to the questions presented in Table 1. Data saturation was achieved as similar data was collected from the respondents who are all consortium partners within the +CityxChange smart city project.

Table 1. Interview questions.

Questions
What information would you like to capture using an EA framework when developing digital services in smart cities?
What techniques does your organisation use to document knowledge that individuals have learnt during a project? e.g interviews, observations or writing documentation.
What techniques does your organisation use to share knowledge? e.g., collaboration, training, or meetings.
Apart from the EA framework, does your organisation use any other architecture for other means? If so, how does it relate to EA framework and can they be combined?
Which problems do you think enterprise architecture can or should attempt to solve?
If you have any other feedback or comments, please add them here.

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4. Results

The qualitative data collected from survey provides new insights on the application of EA in smart cities. All responses from the qualitative data were collected as feedback provided from 13 participants. Table 2 provides an overview of participants information.

4.1. Findings from Demographic Data

Table 2 depicts the demographic information of the 13 participants who provided data on their current EA practice in a smart city project. Findings from Table 2 suggest that majority of the participants are male as compared to female. Regarding the age, 5 participants were among 41 - 50 years, 4 participants are aged from 20 - 30 years, 3 participants are among the age of 31 - 40 years, only 1 participant is aged between 51 - 60 years. The results show that 5 participants have 6 months to 1-year experience with EA, whereas 4 participants have less than 6 months experience. Also, 3 participants have 1 to 3 years' experience and only 1 participant have 4 to 5 years' experience with adopting EA.

The results show that 10 participants have 1 to 3 years' experience with smart city projects, whereas 2 participants have 4 - 5 years' experience and only 1 participant have less than 1 year experience with smart city projects. Regarding the primary role of the respondents' organisations, the respondents are researchers, technical architect, full-stack developer, managing director, software developer, and project engineer. Considering the type of organization, 7 respondents currently work in private organizations, whereas 3 respondents currently work in the universities, and 2 work in research organizations. Lastly, only 1 of the respondents works in city council or municipality.

Results from Table 2 as regards to type of services the respondent's organisation primarily provide suggest that 4 of the respondents are into research focusing on citizen engagement, economics, planning, data analytics, public services such as in smart housing, smart transport or roads, environmental protection, efficient water use etc. and smart city related services. Besides, 3 of the respondents provide innovative services and another 3 respondents provide data related services. Additionally, 2 respondents provide ICT infrastructure related services, and 1 respondent provides energy related service to citizens in smart cities.

Table 2. Demographic information of the participants.

Gender	Age	Type of organisation	Type of services your organisation primarily provide	Primary role in your organisation	Experience in using enterprise architecture	Experience related to smart city projects
Male	31 - 40 years	Research	Provide data	Researcher	1 - 3 years	1 - 3 years

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		organisation	related services			
Male	41 - 50 years	University	Innovation related services	Senior Researcher	1 - 3 years	1 - 3 years
Male	41 - 50 years	Research organisation	ICT Infrastructure related services	Technical Architect	6 months to 1 year	4 - 5 years
Male	31 - 40 years	Private organisation	ICT Infrastructure related services	Full stack developer	6 months to 1 year	1 - 3 years
Female	41 - 50 years	University	Research focusing on citizen engagement	Researcher	6 months to 1 year	1 - 3 years
Male	20 - 30 years	University	Innovation related services	Developing Sustainable Energy Services	Less than 6 months	1 - 3 years
Male	51 - 60 years	Private organisation	Economics, planning, and data analytics	Managing Director	Less than 6 months	1 - 3 years
Male	41 - 50 years	City council or municipality	Public services (housing, roads, environmental, water etc.)	Developing Digital Services	1 - 3 years	1 - 3 years
Male	20 - 30 years	Private organisation	Data related	Conducting research, data analysis and interpretation	6 months to 1 year	1 - 3 years
Male	41 - 50 years	Private organisation	Innovation related	Innovator	Less than 6 months	4 - 5 years
Male	31 - 40 years	Private organisation	Data related	IT Manager	4 - 5 years	1 - 3 years
Male	20 - 30 years	Private organisation	Energy related	Software Developer	Less than 6 months	1 - 3 years
Male	20 - 30 years	Private organisation	Smart city services	Project Engineer	6 months to 1 year	Less than 1 year

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4.2. Descriptive Analysis of Qualitative Data

For the first question the additional information that the respondents would like to capture using EA framework in developing digital services in smart cities. *"The researcher stated that the EA framework model can be useful but there is still some learning curve to understand in properly deploying it and even a steeper one to be able to use it". Also, "the researcher mentioned that EA framework is not suitable for non-practitioners"*. Likewise, *"the full-stack developer stated that the EA framework should be presented in a form that is easily understood by those not familiar with EA"* as a concept to improve its adoption in proving digital services in smart cities.

For the second question what techniques the respondent's organisation uses to document knowledge that individuals have learnt during EA adoption. Findings from the respondents stated that they utilize user manuals, observations, internal document/written documentation in a web-based corporate wiki, interviews, structured surveys, workshops, using the Delphi method. They also use discussions and project team meeting when each project is closed, where details of lessons learned are discussed and captured.

Considering the techniques, the respondents organisation uses to share knowledge on EA adoption for smart city development. Findings suggest that internal document templates, Wiki, meetings, and informal discussions, co-design workshops using digital whiteboards, collaboration, and training.

Findings from the respondents mentioned that apart from the EA framework, their organisation use other architecture for other means. Where the researcher mentioned that *"Yes his organization uses a frameworks and tools relevant to the established enterprise architectures such as TOGAF which is an EA framework that provides model and tool that can be specifically used with other EA frameworks".* Although, the managing director *"stated that at the moment they do not really use other EA frameworks, but his organization intend to use the developed EA frameworks proposed in the +CityxChange smart city project going forward to better align their ICT processes and business systems, starting with staff data"*.

Based on the fifth questions exploring problems the respondents think EA can or should attempt to solve. One of the researchers mentioned that *"EA should introduce frameworks and tools for determining and implementing application and technology architecture, data governance, data interoperability, data security and risk management, relevant regulatory compliance, knowledge retention and in general digital transformation"*. Also, the other researcher stated that "EA should be able to support the defining of blueprint service architecture". The Technical Architect and Full-stack developer highlighter that *"EA should facilitate high level planning and design" and also "depict how different organisations can work together towards the same goal"*. Furthermore, the managing director pointed out that "*EA should be able to address duplication of ICT systems and data" and the project engineer stated that "EA should improve the overall understanding of architecture and forwarding and sharing of knowledge within smart city projects"*.

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Based on the last question one of the researchers stated that *"the terms used within the data collection instrument are difficult for beginners, non-technical synonyms could be used to simplify the data collection of evidence as related to EA practice adoption for provision of digital services in smart cities".*

5. Discussion and Implications of Study

As cities continue to experience digital transformation be providing digital services to their citizens in becoming smart cities [13]. EA is deployed to facilitate the digitalization of urban services. This study investigates EA deployment focusing on the role of EA to support the management of digital services in smart cities. EA deployment can help IT managers and urban planners to provide understanding on how to address complexity issues from an ambiguous and abstract state to a more clear and less technical format. Therefore, this study explores the current practice of EA by IT practitioners and stakeholders involved in smart city project through qualitative data via survey research method.

Findings from this study provides recommendations on how enterprises in cities that provide digital services can assess their readiness in deploying enterprise architecture. Therefore, enterprises will be able to assess their readiness in advance before deploying EA in practice, and better understand the gaps that needs to be addressed. Findings from the literature [23] argued that EA enhances enterprise's IT capabilities and is seen as an indispensable practice aimed at improving enterprise agility. Again, it is observed that findings from this study are congruent with earlier studies [24]; [25] which mentioned that EA defines the present and desirable future states of an enterprise's capabilities, processes, systems, application, data, and IT infrastructure providing a roadmap for attaining this target from the present state.

Findings from this study also confirms that EA attempts to address enterprise issues as pointed out by Anthony Jnr. [1], where the author stated that EA describes the enterprise level, associated data employed within smart city and the relationships among the employed data used to provide digital services. Overall, this study contributes to practice by providing a broader view of role of EA in supporting knowledge management and transfer to improve digital services in smart cities, thus highlighting the capabilities of EA in urban context. From a theoretical point of view, the findings are relevant to researcher as it provides issues that need to be addressed in EA adoption within smart cities that can be further explored by academicians.

6. Conclusion

Enterprise architecture is a practice intended to enhance the management of complex information systems and business strategies [26]. Although EA is widely deployed in different institutions, researchers and practitioners have acknowledge that there is a current lack of empirically validated

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research on EA grounded on qualitative data which provides evidence on how EA contributes to improve digital services in smart cities. Therefore, this study adds to the existing body of knowledge by exploring the current practice of EA by IT practitioners and stakeholders involved in smart city project through qualitative data via semi-structured interview. Evidence from this research present initiatives that impacts the value that can be derived when EA is deployed for management of digital services in smart cities.

The study provides current practice of EA to make cities smarter as a lesson that can be useful to both technical and non-technical practitioners involved in provision of digital services in smart cities. The findings intended to foster and provide more understanding on how enterprises that provide digital services in smart cities and also improve their services. Additionally, this research is based on evidence from Norway and Ireland. Thus, the interpretation of the findings should be confined to these two countries or to areas with similar smart city adoption practice. Further, this research provides qualitative findings only, its credibility needs to be improved by further quantitative empirical evidence. Thus, future work will carry out a cross-sectional survey using questionnaire instrument to further validate EA deployment practice in smart cities for management of digital services.

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Digital readiness through shared values and carefully designed organizational practices

Anne-Christine Rosfeldt Lorentzen*, Christa Thomsen

Aarhus University, Aarhus BSS, Fuglesangsallé 4, Aarhus 8210, Denmark
Aarhus University, Aarhus BSS, Fuglesangsallé 4, Aarhus 8210, Denmark

Abstract

Scholars are increasingly turning towards a focus on humans in digital transformation, highlighting that not only technology itself, but also strategy and leadership are important factors in a successful digital transformation. More recently, scholars have argued that the focus should be on digital readiness when implementing the new digital technology. However, our review of the literature on digital readiness shows that there is a paucity of information in the literature, in specific on *how* managers prepare the organization for digital transformation. With this paper, we aim to contribute to the literature on digital transformation in general and the literature on digital readiness in particular by exploring how managers foster an organizational climate or culture that emphasizes the importance of, and supports, digital transformation. Empirically, we take a point of departure in 28 months of organizational ethnography of a financial institution, which successfully implemented 'Robo-advisor'.

Keywords: Digital transformation; digital readiness; organizational ethnography; organizational culture

1. Introduction

The diffusion of digital technologies has enabled a notable transformation in organizational boundaries, processes, structures, roles, and interactions (Cennamo, Dagnino, Minin and Lanzolla,

* Anne-Christine Rosfeldt Lorentzen. Tel.: +45 20219644
E-mail address: acrosfeldt@mgmt.au.dk

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2020: 5). It is now clear that digital transformation is not just "a traditional IT back-end process; rather it affects the organization as a whole, redefining strategies, entrepreneurial processes, innovation, and governance mechanisms" (p. 5). Thus, the organization has better be well prepared for the transformation. Scholars are increasingly turning towards a focus on humans in digital transformation, highlighting that not only technology itself, but also strategy (e.g. Hess et al. 2016) and leadership (e.g. Gfrerer et al. 2021) are important factors in a successful digital transformation. However, despite the many strategies available for implementing new digital technology, and despite of leaders putting digital transformation at the top of their management agendas (Hess et al. 2016), digital transformations have proven to be much more difficult than both scholars and practitioners expected (Zinder 2016). More recently, scholars have argued that if digital transformations are to succeed, the focus should be on organizational readiness for digital transformation or digital readiness (Gfrerer et al. 2021). However, our below review of the literature on digital readiness shows that there is a paucity of information in the literature, in specific on how managers prepare the organization for digital transformation (e.g. Cennamo, Dagnino, Minin and Lanzolla, 2020). With this paper, we aim to contribute to the literature on digital transformation in general (Hanelt et al. 2020, Vial 2019, and Wessel et al. 2021) and the literature on organizational readiness for digital transformation and digital readiness in particular (Gfrerer et al. 2021; Solberg, Traavik, and Wong, 2020) by exploring how managers foster an organizational climate or culture that emphasizes the importance of, and supports, digital transformation.

2. Cultural dynamics

The concept of culture has a long history, and during the 1940s and 1950s anthropologist found interest in studying the concept in organizational contexts with a focus on customs and traditions of work (Hatch 1993, 657). From the 1980s, management scholars have been interested in organizational culture as a management tool to create strong cultures with the purpose of making organizations more effective and/or successful (e.g. Deal and Kennedy, 1982). Schein (1993) became especially influential, because he developed a conceptual framework for analyzing and intervening organizational culture with the purpose of changing the organization. On several occasions, organization scholars have applied his conceptual framework (e.g. Phillips 1989, Schultz 1995). Schein's (1985) conceptual framework has been equally challenged, for instance by scholars, who highlight, that his definition of culture ignores subcultures (e.g. Barley 1983, Van Maanen and Barley 1985), and scholars who argue – from a symbolic-interpretive perspective – that focus should be on interpreting symbols and symbolic behavior in organizations (e.g. Alvesson 1987, Alvesson and Berg 1992, Putnam 1983, Smircich and Morgan 1983). There are also arguments again conceptual models of organizational culture all together, because such models oversimplify complex phenomena (Hatch 1993, 658). However, Hatch (1993) argues that such models play an important role in guiding empirical research and generating new theory, and that

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Schein's functionalistic model has had – and continues to have – relevance. Consequently, drawing on symbolic-interpretive perspectives on culture, Hatch (1993) has reformulated Schein's model for analyzing organizational culture, in processual terms. Her cultural dynamics-model provides a framework within which to discuss this dynamism of organizational cultures (Hatch 1993, 657). Hatch argues that the advantage of a dynamic version of organizational culture theory lies in the new questions we come to pose. Whereas Schein's view focuses on what artifacts and values reveal about basic assumptions, the dynamic perspective asks: How is culture constituted by assumptions, values, artifacts, symbols, and the processes that link them? (Hatch 1993, pp. 660). Based on Hatch's cultural dynamics-model, we have formulated the following research question: How is an organizational climate or culture that emphasizes the importance of, and supports, digital transformation constituted by the assumptions, values, artifacts, symbols, and the processes that link them in the organization we study?

3. Method

Ethnography (see Spradley, 2016) proposed itself as a helpful method to get an understanding of how managers prepare an organization for digital transformation. It is a way to not only get the organizational members' after rationalizations on implementing the new digital technology, but to study them in their everyday work activities which enables an understanding of the values and assumptions that guide complexity, intricacy and mundanity of organizational life (see Ybema et al. 2009) and, in this case, of managing digital transformation readiness.

3.1. Research context and data collection

The financial sector is an interesting context for studying readiness for digital transformation (purposeful sampling), because the pressure of change is heavily felt in this sector, where banks struggle to change from regular banks into digital banks, in which (i) banking occurs via internet, mobiles, and social media channels, (ii) processes are automatized, and (iii) Robo-advisors support customer interaction (Gfrerer et al. 2021 pp. 23-24). In this ethnographic study, a financial institution is implementing Robo-advisor. Robo-advisor is a digital platform providing automated, algorithm-driven financial planning services with little to no human supervision. Robo-advisors are capable of handling sophisticated tasks and are being put to use in different ways depending on the financial institutions' strategies. The case allowed us to explore what organizational readiness for digital transformation is in a financial institution, and how it can be managed successfully. The financial institution was investigated for 28 months during the digital transformation, from which we draw on 347 hours for this particular study. A compromise between surface investigation and in-depth investigation was adopted (Spradley 2016). This was in order to (i) first seek the organizational context in holistic terms, which allowed us to get an understanding of how the digital transformation was perceived by top managers,

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middle managers, and employees, (ii) then obtain ethnographic focus by studying assumptions, values, artifacts, symbols, and the processes that link them allowing us to culturally explore how managers prepared the organization for digital transformation (Spradley 2016: 101). Observations (Barley 1986) are our main data source, and documents such as WPA, Cultural profiles, Strategy (2019-2021) and working documents for the next strategy (2022-2025) are used for further contextualizing. The analytical process was abductive. Following the methodology of Alvesson and Kärreman (2007), called "Active discovery and/or creation of mysteries and the subsequent solving of the mysteries followed" (Alvesson and Kärreman 2007: 1266), where the researcher(s) searches for deviations from what would be expected, given established wisdom, in empirical contexts, we first did inductive observations, which made us wonder, why the digital transformation succeeded when the financial advisors were frustrated with the digital technology. We then studied the literature and found that digital readiness is a useful term for gaining a deeper understanding of why a digital transformation succeeds. With a point of departure in the concept of digital readiness, we went back to the empirical material and found that culture seems to play an important role in an organization's digital readiness.

4. Findings

When we started our research and entered the organization of our study, the top management had decided to implement Robo-advisor as a "technological" advisor. Right from the start, we noticed that the human financial advisors were not happy with the new digital technology being implemented, which they found to be inadequate. However, we also noticed that the financial advisors did not actively resist or work against the digital transformation. They did express their frustration with Robo-advisor on several occasions when talking to each other and to managers, but they did so along while praising their tasks, colleagues, the organization that they were very proud of, and their leaders. It seemed contra-intuitive that the financial advisors did not actively resist a digital transformation, where banking becomes more digitalized and cashiers are being closed - especially since they were not satisfied with the function Robo-advisor. In exploring, why the financial advisors did not resist or work against implementing Robo-advisor, culture became an interesting phenomenon to focus on. The argument is that a strong "family culture", to use an expression used by the bank itself, became the glue, which had kept the organization together in times of change and crisis, and which also came out as enabler of a successful digital transformation according to the interviews we conducted with the employees. The culture expressed itself through an organization that was true to its mission and core values, where senior managers led the way by expressing their commitment to policies and encouraged open communication and honest feedback. In our detailed analysis, we focused on the values and underlying assumptions that constituted what we call a digital culture. Overall, by applying the cultural dynamics framework, we found that a strong culture based on trust and honest communication encouraged the employees to follow their leaders towards their vision, even though they did not agree with the specific

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technology being implemented. We elaborate on the culture below, which seemed to play an important part in shaping the organizational members' beliefs around the digital transformation.

4.1. Digital transformation through a non-hasty process

From the beginning of our ethnographic fieldwork, the organization's corporate strategy focused on the local community by having human financial advisors available, which was seen as important to the organization's target group, not least the older part of it. Robo-advisor was not explicitly presented to the financial advisors as a 'colleague' who the human financial advisor could consult, and it was not (yet) an advisor, which customers could consult from their homes. Consequently, in this case, the changes did not happen overnight, but at a pace which was seen as more meaningful to employees and customers. Because of this evolutionary-like change process (despite the revolutionary and radical character of implementing Robo-advisor), human financial advisors did not consider Robo-advisor to be a threat to their jobs – even though cashiers were closed, and structural changes happened. The top management's decision of not changing as radically as could have been done, was aligned with the organization's strategy and history: Human contact is important to the organization's customers and employees, and it shows throughout the organization; with positive management evaluations, positive colleague evaluations, a popular brand, *and* employer brand (the organization often wins awards positioning them as a 'Great Place to Work' and 'Best with customers'). Along the same line, the organization never has difficulties attracting employees with the right skills and mindset, and new colleagues often explain their shift from other financial institutions to this particular one, with the trust shown in employees compared to the degree of control they had experienced in similar organizations within the financial sector.

4.2. Digital transformation through meaningful tasks

After two years, the human financial advisors had accepted Robo-advisor. During the first two third of the ethnographic fieldwork, however, they agreed that the specific system – especially the function of it - was very frustrating. When stating this, however, they always stressed, that they really enjoyed their tasks, respected their colleagues and were proud to work in the organization. This communication process linked artifacts (good evaluations, positioned high within the sector regarding customer satisfaction and employer satisfaction), values (one can be proud to work in this organization; it is nice to go to personal events, because people respect and recognize the organization; "we help each other out"; "we are happy to go to work"; "this is a flat organization" (hierarchy); the management has the organization's best interests in mind; "we can trust our management"; "we communicate honest and freely horizontally and vertically"), and assumptions (we are one big family; we make a difference to the local community; we are not just a bank).

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5. Conclusion

Summing-up, our analysis shows that a culture based on trust and honest communication combined with a non-hasty change process without visible layoffs, a process which allowed the employees to collaborate with robo-advisor as a new colleague and member of the family on meaningful tasks, encouraged them to follow their leaders through the digital transformation, even though they did not at first appreciate the specific technology being implemented.

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Extension of Socioemotional Wealth Perspective with the Process of Selecting Local Family Business Successors

Shogo KAMEI[a] ・ Hiroaki ITAKURA[b]

Setsuko SHIBUYA[c]
[a,c,]The University of Fukuchiyama,Kyoto,Japan
[b]Advanced Institute of Industrial Technology,Tokyo,Japan

Abstract

This research paper aims to investigate the socioemotional wealth (SEW) that coexists with long-term investment for sustained growth in the process of selecting family business successors. Through the analysis of local family businesses in Japan, changes in the successor selection process were clarified by implementing the extended SEW concept, which relates to the pursuit of continuous profits by various stakeholders.

Keywords: socioemotional wealth, sustained growth, family business, successor selection process, extended SEW concept

1. Introduction

Transferring the ownership and management from the founder to the next generation is a significant issue for family-owned businesses (Gersick et al., 1997). Characteristics of succession within family businesses include the limited number of potential successors and the emotional connections when there are familial ties between the current manager and their successor. Therefore, succession in family businesses has been highlighted as more complicated than management changes in a non-family one (Le Breton-Miller et al., 2004). With uncertainty on the rise, strategic decision-making has become increasingly important for local family business managers in planning sustained growth. There has also been a rise in opportunities that require long-term investment decisions that affect successive generations. Nevertheless, matters tend to involve a trade-off between meeting the founder's emotional needs and long-term investment plans, such as the generation of new businesses. This research paper seeks to contribute to the sustained growth of local family businesses by reducing the need for these

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trade-offs and by highlighting the process of selecting successors while balancing both sides. This study investigates the SEW that coexist with long-term investment in selecting successors of local family businesses in Japan.

2. Literature review of previous research

A meta-analysis by Chrisman et al. (2003) on 190 theses regarding family businesses published between 1996 and 2003 indicated that approximately 22% is the highest proportion, related to business succession. Business succession can be said to attract the most attention within the field of family businesses. There are several research topics concerning business succession. Of particular note are the mixed positive and negative results for the relationship between the form of the succession and a business's success, with no definitive conclusion yet being drawn. Empirical research concerning strategies has produced verifiable results that family businesses are passive toward R&D investment (Asaba and Wada, 2014). Family businesses tend to be risk-averse in terms of their business strategies. However, there is also little shortage of family businesses that actively restructure their core business and push innovation to achieve long-term stability (Okumura et al., 2010).

In terms of socioemotional wealth (SEW), Gomea-Mejia et al. (2011) note the assumption that family businesses prioritize non-financial utility over economically rational utility. This is the result of decision-making led by the social motivations of societal recognition and familial harmony. Iriyama and Yamanoi (2014, P.31) note three types of non-financial utility in SEW. The first is the strong emotional ties a family has with their business and the idea that their family name prospers along with the company. The second is the permanency the family achieves through their business, and the third is the level of altruism within the family. Miller and Le Breton-Miller (2014) criticize the fact that past SEW has tended to lead to the pursuit of short-term profit and put forward the concept that extended socioemotional wealth can lead to the pursuit of continuous profits for a variety of stakeholders. They propose that a family business's innate strength is based on this and also relies on behavior that contributes to producing long-term profits.

Some ethnographic works may shed light in this respect. For instance, Firth, in a study on political and social structures in the Pacific islands, discusses that while a well-defined system of patrilineal or matrilineal succession "gives genealogical persistence… it does not account for the actual succession of individual to individual" (1964, P. 69). The system has ways of preventing an incapable or irresponsible person from taking office, and hence, an unrelated person may succeed to power. Also, anthropologists studying Japan have noted that *ie*, which translates literally to "house" or "household," is not necessarily a kinship unit based on ties of descent or bloodlines. It is rather a group of people united with social, economic, and also emotional ties. Nakane, a prominent Japanese anthropologist, rightly captures the essence of belonging to *ie* as "a personalized relation to a corporate group based on work" (1983, P. 260). Furthermore, *ie* is not only an financial unit, and its functions cover a wide range

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of social activities from religious to welfare in everyday life of its members (Pelzel,1970; Bachinik,1983). Drawing on these discussions on Japanese *ie* system, Kondo illustrates its ongoing prevalence in contemporary Japanese companies in her ethnography on a factory in Shitamachi in Tokyo, where small and old companies are congregated. She states that *ie* is "perhaps best understood as *corporate groups* that hold property… in perpetuity" (Kondo,1990, P.122), where non-kin members are also incorporated as family members. Referring to this corporate culture where unrelated people are treated as if they are family or kin members, she introduces the term "company as family" and "family as company" (1990, P. 177).

3. Interviews

The managers of two family-owned companies located in an urban region of the Tokyo Metropolitan Area and the northern part of Kyoto were interviewed to verify the hypothesis. Yukiko Yamamoto, Representative Director and President of FUJIRIKUSOU Co., Ltd. (Ota-ku, Tokyo), was interviewed twice via Zoom on July 21, 2020, 19:00–20:45 and on July 28, 2020, 19:00–20:45 attended by all the authors. Daisuke Inoue, Representative Director and President of INOUE Co., Ltd. (Fukuchiyama City, Kyoto), was interviewed by the first and third authors at his office on October 19, 2020, 13:30–15:00. The following is an extract from the record of those interviews.

4. Investigation

From these two interviews, we verify the hypothesis that "family businesses that are aiming for permanent stability through long-term investment form an extended SEW with employees by forming an intimate relationship with the society around them."

In the case of FUJIRIKUSOU, the current president, who succeeded due to her predecessor's age established five new offices in areas near her customers and collaborated with them to start a land transport matching business for ocean containers and a container storage business while carrying out long-term investment schemes. She has formed a deep bond with her customers by maintaining a trading relationship over many years based on customer-centric management philosophy. However, she said such reforms were triggered by the desire to reduce the burden on employees by improving efficiency. In addition, it is perceived that long-term investment for the company's continued development was implemented due to the desire to make employees happy. This process involves a unified approach with employees and takes a severe view of relatives who do not contribute. On the other hand, she feels that her relatives are the company itself and cannot separate it from her parents and own life. In terms of succession, she hopes that both relatives and employees will be on the Board and hopes that the company will become a public institution for society.

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INOUE, the current president of his company, succeeded his predecessor due to the deterioration in business conditions. He felt the importance of employees listening to supportive customers during the plans to rebuild the business and has embarked on long-term investment for sustainable management. He understands that the long years of successful translations with customers are because of their bonds with his employees. He has reformed the organization so that employees can feel happy by demonstrating their independence. This is seen as necessary in following the company's philosophy of treating people with care and respecting human life. In terms of succession, he is not particularly concerned about it being a relative, and any person inside or outside the company with the same philosophy could be a candidate. He expects his successor to create value in the local community.

In both cases, it can be said that sustained management through long-term investment is possible through the formation of extended SEW with employees by forming an intimate relationship with the local society of employees and customers.

5. Conclusion

The results of the two interviews support the hypothesis that family businesses that are aiming for permanent stability through long-term investment form an extended SEW with employees through the formation of intimate relationships with local communities. Moreover, this influences the fact that relatives may not necessarily become candidates when selecting successors. Nevertheless, the above results are still taken from a qualitative survey of two local family businesses in Japan, and there are no advanced case studies. In the future, we hope to accumulate examples from both Japan and overseas and to verify our hypotheses through quantitative research.

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Investigating the Impact of Enterprise Architecture Adoption in Smart Cities

Bokolo Anthony Jnr.*, Sobah Abbas Petersen, Eldar Hauge Torkelsen

Department of Computer Science, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

Abstract

Enterprise architecture (EA) provides a medium to transform an enterprise and to continually align the institutions business and Information technology (IT) strategies. But, presently Enterprise Architecture (EA) adoption is significantly low irrespective of the benefits organizations can derived from implementing EA. Similarly, there are fewer quantitative studies that examines the impact and benefits of EA towards urban development. Therefore, this research explores the significant issues that influence EA adoption in smart city context. Accordingly, survey data collected from respondents in 18 enterprises based in Norway and Ireland was used to provide evidence on the determinants that influence EA adoption for smart city development and towards the validation of the EA framework that was developed in +CityxChange (https://cityxchange.eu/) smart city project. Finding from this study suggest that the developed EA framework supports smart city development. Also, the findings support decision makers in focusing on the main issues that influence EA adoption in urban context. Besides, the findings provide better insights for enterprise architects and practitioners on how their EA deployment plan and strategies can facilitate smart city development.

Keywords: Information systems; Enterprise architecture adoption; IT practitioners; Smart cities; Urban development; Survey questionnaire.

* Corresponding author. Tel.: +47-41398239; fax: +47-41398239.
E-mail address: anthony.j.bokolo@ntnu.no

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1. Introduction

Enterprise Architecture (EA) provides several benefits to organizations as it supports interoperability and agility, facilitate decision making in IT deployment, lessens IT costs, etc. [1]. It provides support and direction in the design, transformation, and management of business process to support organizational development. It also entails the representation of a high-level view of an institution's IT systems and business processes, their interrelationships, and the degree to which these IT systems and processes are shared by several parts of the organization [2]. EA can guide the transformation of an enterprise by managing the use and development of information systems. It aids in describing the organizational business strategy, technologies, data, and Information System (IS) on different levels based on the current and future states [3]. EA can primarily be used for guiding the realization of organizational initiatives to support business and IT planning, communication, strategic management, and decision-making [4].

EA also help decision maker for quality assessment [3]. Currently, EA is mostly adopted in industries and governmental institutions to manage IT landscape, as a continuously changing process for enterprises [5]. EA helps to supports stakeholders to plan and develop projects and possibly guides IT managers and Chief Information Officer (CIOs) in skills development and the allocation of IT human resources [6]. Thus, EA can be seen as a process (in terms of definition) and as a product (employed for representation) [3]. EA documentation that are being employed comprises of standards, architectural models, principles, and other resources aimed at guiding urban development activities. EA frameworks such as TOGAF or the Zachman framework are currently deployed in enterprises to provide guide towards IT development [3].

Currently, EA adoption is significantly low irrespective of the benefits urban environments can derived from implementing EA. Similarly, there is fewer quantitative studies that examines the impact and benefits of EA for urban development. Along this line of thought, this research aims to address the following research questions:

- What are the benefits of adopting EA in smart city context?
- What are the issues that influences the adoption of EA in smart city context?

Given the lack of empirical grounded EA studies in smart city domain, this study provides a quantitative investigation of the issues that impacts the adoption of EA by practitioners in a smart city project. Findings from this study contributes by providing discussion for the observable issues faced by organizations when they adopt EA. The findings provide researchers and practitioners with insights into improving EA adoption. This paper is organized as follows: In the next section, the literature review is described. In section 3 the methodology employed is discussed. Section 4 is the results, and section 5 is the discussion. Finally, the conclusion is presented in section 6.

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2. Literature Review

Several studies have been directed to explore EA adoption in institutions among these studies Foorthuis et al. [7] researched on EA benefits and conformance in systems development. The researchers aimed at identifying several significant benefits that have not yet been fully realized in organizations. Gong and Janssen [5] explored causal factors that impacts the failure of EA based on literature review. The authors aimed to investigate the factors influencing EA failure in practice based on deployed approaches, tools, and methods to create business value. Ajer and Olsen [8] explored the challenges of EA based on a case study. Their study aimed at providing an understanding of the main issues faced by organizational acceptance of EA in projects. Al-Kharusi et al. [9] provided a comprehensive research perspective view for EA. Findings from the study provided a foundation for new researchers in EA domain through presentation of research theories and methodologies which are required in designing future EA studies.

Sobczak [1] implemented an EA-based model for management of smart cities for defining the main components and outlining directions for future improvements. This helps in achieving transformation of cities into smart cities. Weiss et al. [10] studied the effectiveness and institutionalization of EA management grounded on institutional theory by proposing nine hypotheses which were validated grounded on quantitative empirical data. The author aimed at actualizing EA management benefits across organizations. Jahani et al. [11] assessed EA readiness within enterprises based on a developed model. The authors identified key factors which are important in evaluating organizations. Findings from their study aid organizations to evaluate their readiness before implementing EA in practice, thereby identifying any existing issues.

Findings from the literature [2]; [6] indicated that EA provides cities with the capacity to identify and make suitable changes, providing flexibility and stability in the city`s operations. EA can be seen as an approach supported by a framework which is able to organize many facets that constitute the fundamental crux of city`s services in a holistic way [12]; [13]. While findings from prior studies [3]; [4] suggest that EA provides several benefits to enterprises and cities the issues or determinants that negatively impacts their realization are widely unexplored. However, studies that explores and provides understanding of the issues that affects EA realization is highly worthwhile both from a theoretical and practical point of view [14]; [15]. Thus, this current study adds to the body of knowledge by providing benefits of adopting EA in smart cities and presenting the issues that influences the adoption of EA in smart city context.

3. Methods

This research employs a quantitative survey method using a questionnaire instrument. The questionnaire was developed to collect data on researchers and practitioner's perception on EA adoption

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in smart city project using purposive sampling. Each respondent is familiar with enterprise architecture adoption in smart city domain. The data was collected from respondents from 18 organizations in Norway and Ireland involved in the smart city project +CityxChange (https://cityxchange.eu/) where an EA framework was developed. The data collection took place between November 2020 to January 2021 by the means of the online survey questionnaire. Invitations were sent in November 2020 and in January 2021 additionally reminder was sent to participants to partake in the survey.

The first section of the questionnaire provides an introduction of the research to prospective participants and consent was obtained from the eligible respondents. The second section collect data as regards to the demographic information of the respondents (gender, age, organization type, type of services primarily provided, primary role, and years of experience with EA), based on an ordinal scale. The third section of the questionnaire collected data based on the respondent's perception towards the adoption of EA and usefulness of EA use case scenarios for smart cities to support urban development. The data helps towards the validation of the EA framework that was developed in the +CityxChange project [16], which comprises of seven layers (context, service, business, application and data processing, data space, technologies, and physical infrastructures), and perspectives (stakeholder and data). The question items were measured based on a 5-point Likert scale ranging from strongly disagree to strongly agree. Data collected from the survey was analyzed via descriptive statistics in Microsoft Excel.

4. Results

Findings from the data as regards to gender suggest that 92 % are male and 8 % are female as seen in Figure 1a.

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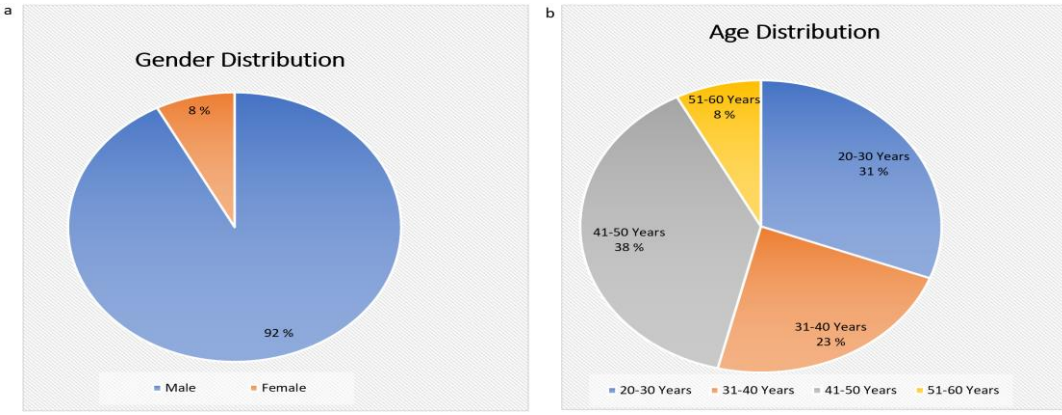

Fig. 1. (a) Gender distribution of respondents; (b) Age distribution of respondents

Also, regarding the age distribution results from Figure 1b suggest that 38% of the respondents are between the age of 41-50 years, then 31% are between the age of 20-30 years. Also, 23% are between the age of 31-40 years and lastly 8% are between the age of 51-60 years.

In terms of the type of organization results from Figure 2a show that 53.8% of the respondents presently work in a private organization, whereas 23.1% are from the university, 15.4% are from research organization, and lastly 7.7% presently work at city council or municipality.

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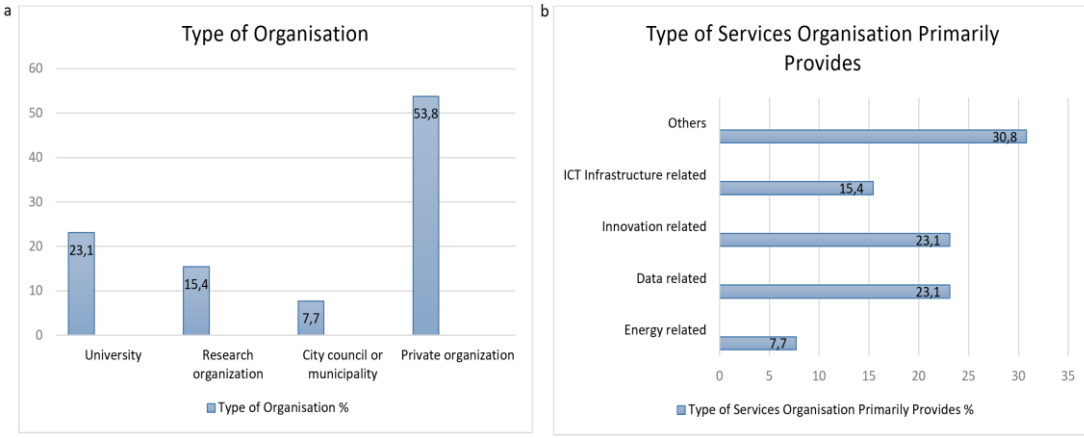

Fig. 2. (a) Type of organization distribution of respondents; (b) Type of organization distribution of respondents

As regards to the type of services results from Figure 2b reveal that 23.1% of the respondents work in enterprises that provides data related and innovation related services to citizens in smart cities. Whereas 15.4% provides ICT infrastructure related and 7.7% provides energy related services. The other 30.8% provides other types of services such as research focusing on citizen engagement, economics, planning, data analytics, and public services, housing, roads, environmental, water etc. as reported by the respondents.

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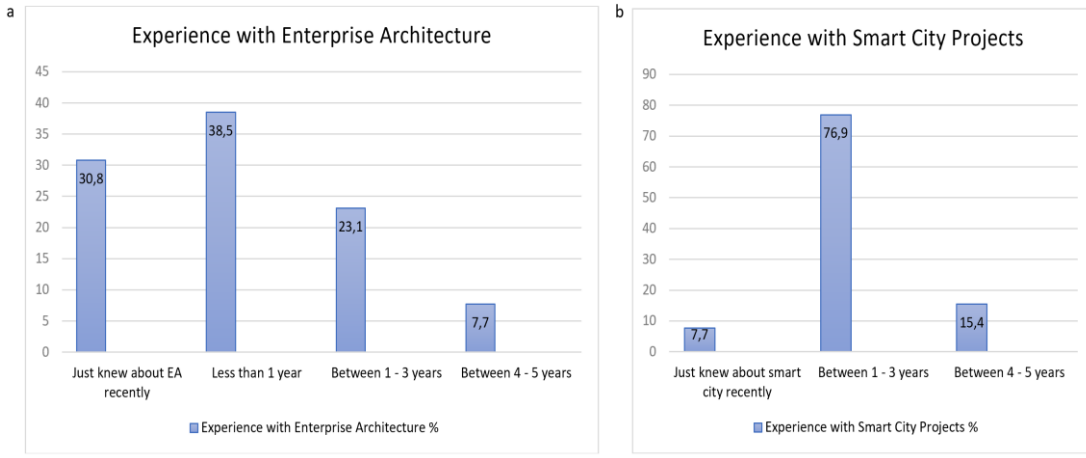

Fig. 3. (a) Distribution of experience with EA adoption; (b) Distribution of experience with smart city projects

Results from Figure 3a indicate that 38.5% of the respondents have experience with EA for about 6 months to one year. Then, 30.8% have less than 6-month experience with adopting EA and 23.1% have prior experience of about 1-3 years. Lastly, 7.7% has experience of between 4-5 years.

Additionally, results from Figure 3b indicate that 76.9% have experience with smart city projects for about 1-3 years, 15.4% have experience with smart city projects for about 4-5 years, and lastly 7.7% just recently knew about smart city.

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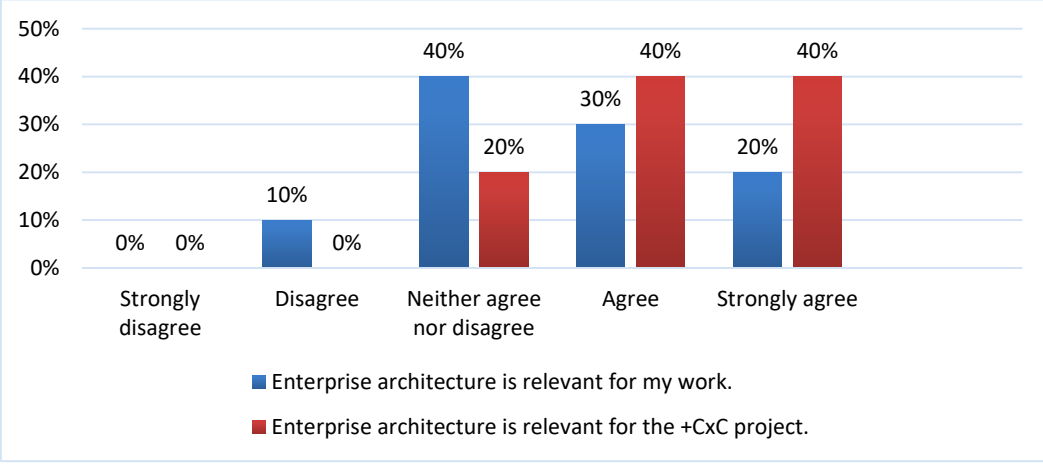

Fig. 4 Distribution of relevance of enterprise architecture

Furthermore, results from the survey as seen in Figure 4 suggest that about 40% of the respondents believes that EA is relevant for their work as well as for the smart city project (+CityxChange). Although, 10% of the respondents feel EA is not relevant for their work.

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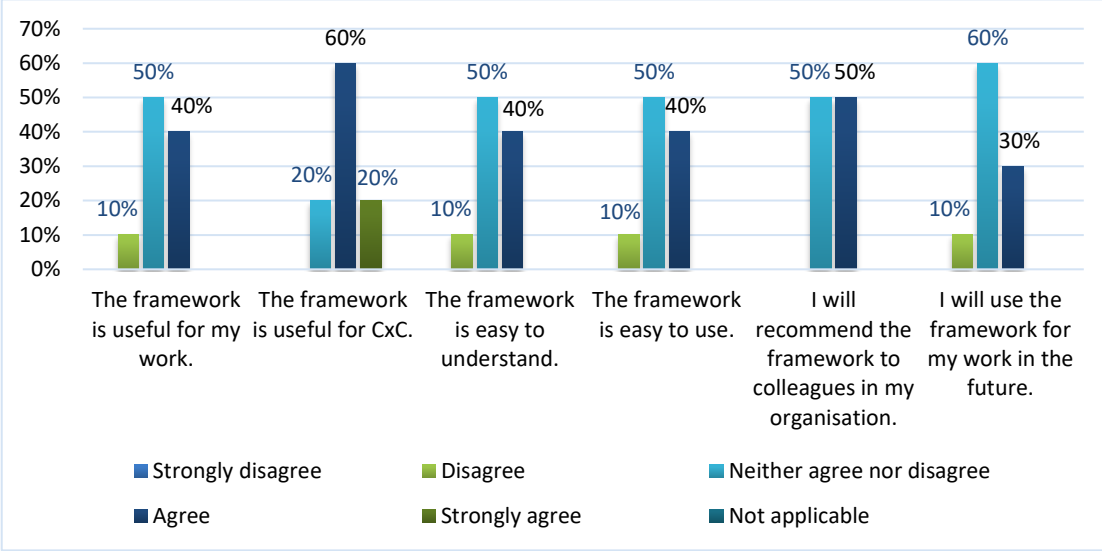

Fig. 5. Perception of respondents in relation to the developed EA framework [16], relevance

Results from the survey as seen in Figure 5 suggest that the respondents neither agree nor disagree with the usefulness of EA framework [16], in their current work.

Also, 60% of the respondents agree that EA framework [16], is useful for the current smart city project.

Besides, the results suggest that the EA framework [16], is easy to understand and use.

Lastly, the respondents agree that they will recommend the EA framework [16], to their colleagues in their organization and 60% states that the EA framework [16], will be used for future work.

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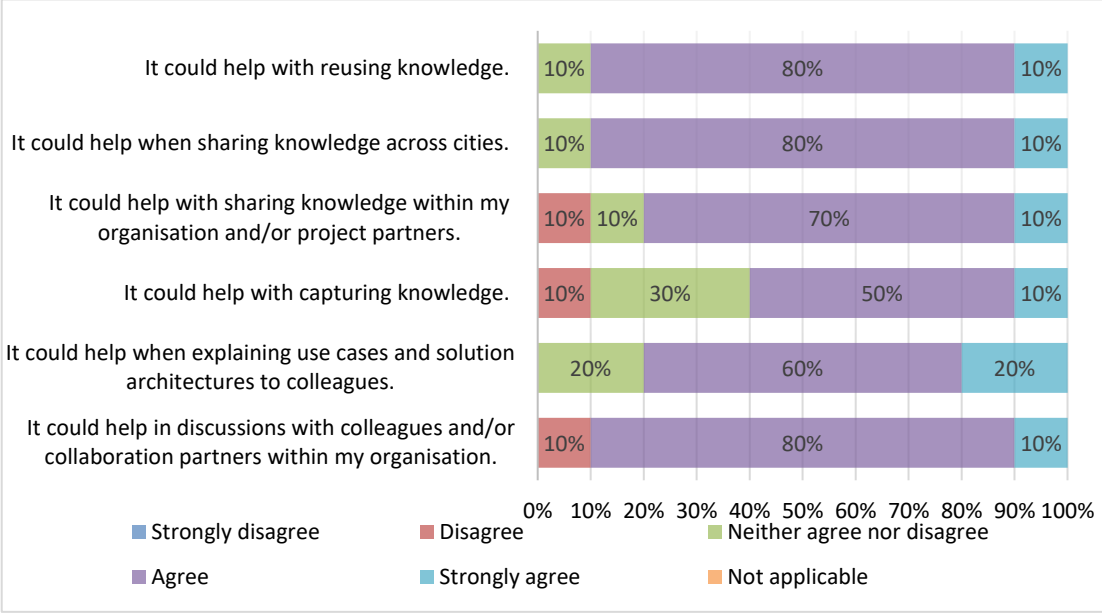

Fig. 6. Perception of respondents in relation to the developed EA framework relevance to knowledge transfer

As seen in Figure 6, 80% of the respondents stated that the EA framework could help in discussions with colleagues and/or collaboration within my organisation, the EA framework could help when sharing knowledge across cities, and the EA framework could help with reusing knowledge.

In addition, 70% of the respondents confirmed that the EA framework could help with sharing knowledge within their organisation.

Also, 60% highlighted that the EA framework could help when explaining use cases and solution architectures to colleagues. Lastly, 50% stated that the EA framework could help with capturing knowledge within their organizations.

Likewise, results from Figure 7 suggest that 60% of the respondents strongly agree that they will recommend use case models modelling in the developed EA framework to colleagues in their organisations.

Also, 50% of the respondents agree that they will employ use case models for future work and the use case models have helped them to clarify details about use cases of services developed to make cities smarter.

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Additionally, 60% of the respondents indicated that they find it easy to describe a scenario using the use case models and 50% believes the use case models are easy to be understanded.

Lastly, 70% indicated that use case models are useful for smart city project and 40% feel that overall use case models are useful for their work.

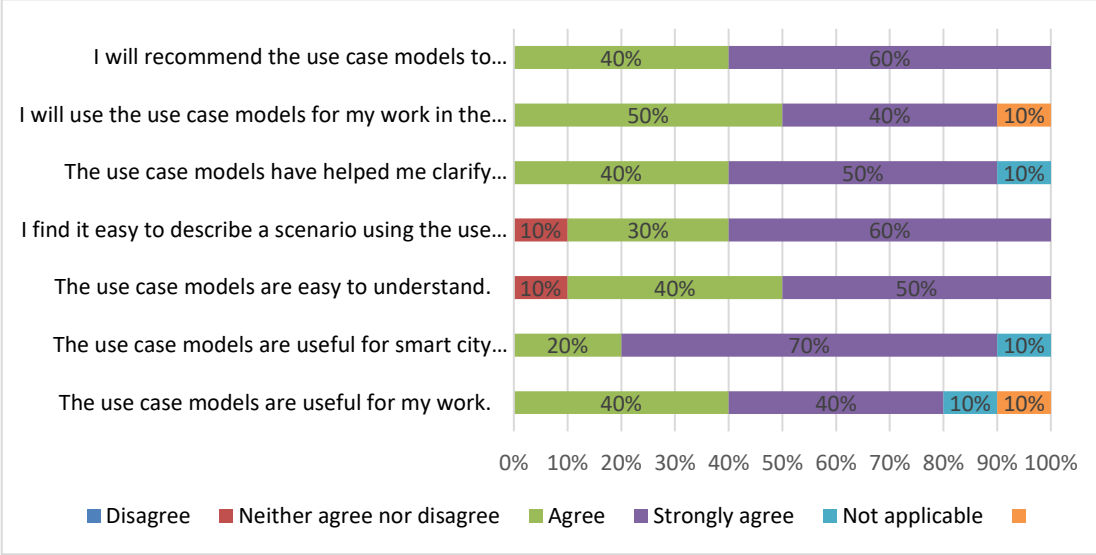

Fig. 7. Perception of respondents in relation to EA framework relevance

5. Discussion

The purpose of this study is to investigate how practitioners can motivate a greater adoption of EA to support cities into smart cities. By means of the survey this research provide evidence on the issues and benefits of EA adoption in urban environment. Therefore, this study explores the impact of EA adoption in smart city context. Data was collected from survey questionnaire and the results suggest that EA can support cities to develop strategies and integrate them with existing urban processes as mentioned in the literature [13]. Findings from Anthony Jnr [4] posited that EA is holistic as it encompasses a wide range of spectrum from business, information, and technology to management. The scope of EA comprises of the people, processes, IT, and their inter-relationship.

EA aids synergy of IT and business elements that constitute the city`s operation. But the adoption of EA is still faced with challenges which negatively impacts the successful implementation of EA. Besides, findings from the prior studies [10]; [11] suggest that EA is becoming increasingly employed

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in many large organisations, but these enterprises still struggle with truly effective adopting EA. Irrespective of the growing need for EA, there are issues that ranges from people to technology that impacts against EA adoption [13].

Findings from the survey suggest that enterprise architecture is useful to be adopted in smart city project. Additionally, the results suggest that the developed EA framework [16] is applicable to be employed in smart city towards urban development as it provides knowledge transfer, aids in modelling use case scenarios for different smart city services.

6. Conclusion

This study aims to enhance understanding of the determinants that affect EA adoption in urban context. Additionally, this study offered insight into the benefits of adopting EA in urban context and the issues that influences the adoption of EA in smart city project. Quantitative research method was employed in this study and data collected from respondents in 18 enterprises based in Norway and Ireland was used to provide evidence on the issues that influence EA adoption for smart city development. Findings from this study can contribute to both business industries, municipalities, and the academic field. Also, every study has limitations and this study is not an exception. First, cross-sectional data was collected from only two countries to provide empirical evidence on the adoption of EA in smart city project. Secondly, only fewer samples were employed in this study. Hence, there is need to collect longitudinal data from more countries and practitioners in several organizations to examine benefits of adopting EA in smart city context and the issues that influences the adoption of EA in urban context. Such data could provide insight to examine or develop a theory for EA adoption.

Acknowledgements

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A closed-loop control for a cooperative innovation culture in interorganizational R&D projects

Katharina Dieterich[a], Peter Ohlhausen[b,c]

[a]*University of Stuttgart, Graduate School of Excellence advanced Manufacturing Engineering (GSaME), Nobelstr. 12, 70569 Stuttgart, Germany*
[b]*Fraunhofer Institute for Industrial Engineering IAO, Nobelstr. 12, 70569 Stuttgart, Germany*
[c]*Reutlingen University, Alteburgstr. 150, 72762 Reutlingen, Germany*

Abstract

Since project managers only have a limited authority in interorganizational R&D projects a cooperative innovation culture is essential for team cohesion and thus for achieving project scope in time and cost. For its development different factors depending on underlying values are essential. These factors must be learned iteratively by the project members so that they are living the values of a cooperative innovation culture. Hence, this paper raises the following research question: "How to control living the values of a cooperative innovation culture in interorganizational R&D projects?" To answer this question, a closed-loop control for a cooperative innovation culture is developed. The developed closed-loop control system includes several different functional units which show essential roles and several different variables which show what to consider and design in the control system. In addition, the developed closed-loop control system is generalized for other types of projects such as intraorganizational projects.

Keywords: Closed-loop control; Cooperative innovation culture; Interorganizational projects.

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A method for project portfolio risk assessment considering risk interdependencies – a network perspective

Camilo Mican[a], Gabriela Fernandes[b], Madalena Araújo[c]

[a]*University of Valle, Logistic and production research group, Cll 13 # 100-00, Cali 760034, Colombia*
[b]*University of Coimbra, CEMMPRE, Department of Mechanical Engineering, Polo II, Coimbra, 3030-788, Portugal*
[c]*University of Minho, Centre Algoritmi, Avenida da Universidade, Guimarães 4800-058, Portugal*

Abstract

Project portfolios represent the bridge between projects and strategy. However, the final results may not be as expected because materialization of risk factors. Hence, literature has acknowledged project portfolio risk assessment as an element of the project portfolio risk management, being the element that provides information on the importance of risk factors. For that, some specific characteristics should be considered, such as risk interdependency influence and the risk factors impact over portfolio higher levels. Thus, this study is focused on the development of a method for project portfolio risk assessment that considers both risk factor interdependencies and their impact on the strategic objectives as a network. In addition, the method also allows incorporating both risk factors derived from projects and derived at project portfolio level. A representative example is provided to illustrate the proposed method.

Keywords: Project portfolio; risk assessment; risk factors; network theory.

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Addressing the Challenges to Successfully Manage University-Industry R&D Collaborations

Gabriela Fernandes[a], David O'Sullivan[b], Luís Miguel D.F. Ferreira[a]

[a]*University of Coimbra, CEMMPRE, Department of Mechanical Engineering, Polo II, Coimbra, 3030-788, Portugal*
[b]*National University of Ireland Galway, Galway University Road, H91 TK33, Galway, Ireland*

Abstract

University-industry R&D collaborations (UICs) are becoming more critical for discovering innovations that can lead to the development of new products, services, and processes and, more broadly, social impact in terms of employment, economic development, and public health. The Covid-19 pandemic, for example, has seen an unprecedented rise in UICs and illustrates how vital their success can be for positively impacting the collaborators involved and society at large. Several challenges face the successful execution of UICs, not the least of which is the cultural difference between the collaborators. Overcoming these challenges is the subject of several research initiatives that seek to identify the critical success factors (CSFs) that UIC consortiums can use to develop their internal capabilities and project management maturity. The challenges facing one large UIC have been studied in Portugal. Practitioners and researchers were involved in generating insights into how the UIC could be more effective. This paper presents some of these challenges facing the UIC and how they were addressed. It also offers early results into the CSFs deemed essential by researchers and practitioners based on their experience together over seven years. Top CSFs include senior management commitment, effective communication, stakeholder engagement, good leadership, clear and realistic goals, mutual trust and respect, interpersonal teamwork, and clear roles and responsibilities.

Keywords: University-industry collaborations; R&D programs and projects; Management challenges; Critical success factors; Lessons learned, Key practices.

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Adoption and impact of management standards - position paper

Alexandra B. Tenera[a], João Varajão[b]

[a]*UNIDEMI, DEMI, NOVA School of Science & Technology (FCT), Universidade NOVA de Lisboa, Campus de Caparica 2829-516, Portugal*
[b]*ALGORITMI Center, University of Minho, Campus de Azurém, Guimarães 4804-533, Portugal*

Abstract

Standardization makes its contributions to many aspects of our lives, although often that contribution is unnoticed. For example, management standards, such as the ISO 9000 family, establish a common ground perspective that enlarges companies' markets and boosts its international reaching, technological development, and innovation while supporting continuous quality improvement in products and services both at a national and international level. Notwithstanding the recognized relevance of some management standards, especially the ones that have an associated certification system to support its knowledge (e.g., ISO 9000 family), little is known about the impact of the standards (e.g., ISO 21500 family) adoption in increasing organizations' performance regarding, for instance, quality, safety, efficiency, or interoperability. This hinders the standards' dissemination and potential use and unnecessarily delays its revision and further development. To help fill this gap, this position paper proposes a research project that includes the development of a model and an observatory focusing on the adoption of management standards. The expected contributions are: 1) at a theoretical level, a new conceptual model for the explanation and assessment of the adoption of management standards and related impacts; 2) at a practical level, a new information system (observatory) which is expected to be a tool for understanding the adoption of standards, as well as for monitoring and publicizing the results obtained from standardization practices.

Keywords: management systems; standardization; standards; ISO; adoption; success; impacts.

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An analysis of how well serious games cover the PMBOK

Etiane Marcelino, Luísa Domingues

Avenida das Forças Armadas, Edifício I, Reitoria 1649-026 LISBOA Portugal

Abstract

Playing the role of project manager requires a certain level of knowledge and experience from previous projects, thus enabling better decision making. The use of serious games increasingly allows newer project managers to gain the necessary experience and knowledge in a controlled environment. Since several serious games have been developed, the need then arose to conduct a study to measure the level of coverage these simulators provide to the PMBOK. Fifteen games were included in this study and it is remarkable the effort that has been made to improve these tools, as it was found that of the 12 games, 7 covers at least 3 of the 5 process groups found in the PMBOK. It was also found that more than 80% of the serious games cover time management and that less than 20% of the games do not cover the procurement area. Our study recommends that comparative studies be done between simulators in ways to evaluate the improvements that newer simulators bring. Studies to evaluate the teaching learning method of the simulators should also be conducted so that the efficiency of this teaching learning method can be evaluated.

Keywords: Project management; Serious game; Educational games.

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An experimental study on the effects of gamification on task performance

Changiz Hosseini [a], Oda Humlung [a], Asle Fagerstrøm[a], Moutaz Haddara[a]

[a]*Kristiania University College, School of Economics, Innovation and Technology, 0152 Oslo, Norway*

Abstract

This experimental study investigates the effects of gamification on task performance. A between-group experimental design was used in relation to the Covid-19 pandemic where the participants were asked to perform tasks related to: a) hygiene and infection (wash hands, keep distance, etc.), b) routines (walk every day, be social with friends, clean the house, etc.), and c) personal issues (learn something new, check in with a friend, etc.). The test group used an application based on a gamified system and the control group used the same application without a gamified system. Our main findings suggest that gamification has increased the quality of work in task performance and subsequent deliveries over time. In addition, gamification has positively affected on-time deliveries. If a deadline was missed, gamification motivated users to always deliver. The contribution of this study to research and implications for management are discussed, and future research avenues are presented.

Keywords: Project management; task performance; gamificaiton; experiment.

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Application of the PM² Methodology in the Project Management of the Portuguese Project Management Observatory Creation – Initiating Phase

Sofia Ribeiro-Lopes[a], Anabela Tereso[b], José Luís Ferreira[c], Paulo Sousa[b], Pedro Engrácia[d]

[a]*Master's in Engineering Project Management, University of Minho 4800-058 Guimarães, Portugal*
[b]*ALGORITMI, Department of Production and Systems, University of Minho, 4800-058 Guimarães, Portugal*
[c]*PM² Alliance Portugal, Lisboa, Portugal*
[d]*APOGEP, Praça Rocha Martins 4C, 1600-756 Lisboa, Portugal*

Abstract

The Portuguese Project Management Association (APOGEP) launched in September 2020 the project of implementation of the Portuguese Project Management Observatory (PPMO), a non-profit organization with a focus on the status and evolution of project management in Portugal. The project is being managed using the PM² methodology, developed by the European Commission (EC) that has been available, since 2016, free of charge to the general public. The methodology has few scientific references, so this project was used to contribute to filling this gap. The methodology incorporates best practices from other bodies of knowledge, can be easily applied and allows for customization. The initiating phase has been completed and the details of its implementation are focused on in this paper. The client involvement from an early stage was crucial and it was necessary to use more artefacts than those mentioned for this phase. Therefore, this paper presents the tailoring of the PM² methodology to the PPMO project, for the initiating phase.

Keywords: PM² Methodology; Project Management; APOGEP; Portuguese Project Management Observatory.

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Assessment of the Regional Current Liquidity in the Construction Industry of the Czech Republic

Eva Vitkova[a], Lucie Vankova[a], Gabriela Kocourkova[a]

[a]*Brno University of Technology, Faculty of Civil Engineering, Veveri 331/95, 602 00 Brno, Czech Rebublic*

Abstract

In these times, when the whole world is paralysed by the Covid-19 pandemic crisis, every company needs to maintain its ability to pay its debts. Such solvency represents one of the most important factors of financial health. The authors focused mainly on the research into current liquidity in the construction industry and whether the construction companies use external resources for their cash flows to a reasonable extent. The scientific literature sources use for this purpose the ratio of own and external resources as a 50:50 ratios, a reasonable ratio may also be 40:60 [1]. The authors of the article took into account a 5-year period related to the national statistics given by the Ministry of Industry and Trade within the construction sector [2]. However, since the sum of the national data on current liquidity and use of external resources in the construction sector can be misleading, these indicators were also monitored at the regional level. The Czech Republic has 14 regions, which vary considerably in terms performance [3]. The aim of the article is to show the regional financial situation in the construction industry in relation to the national statistics and establish a ranking of the financial performance of the regions within the construction industry using multi-criteria analysis. The research question was how much the regional statistical outputs differ from the outputs of the national statistics.

Keywords: Construction companies; Ministry of Industry and Trade; Current liquidity; Other financing resources; Region.

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Challenges of Cloud-ERP Adoptions in SMEs

Moutaz Haddara, Sara Gøthesen, Marius Langseth

Kristiania University College, 7-9 Prinsensgate, 0186 Oslo, Norway

Abstract

This research examines the challenges of cloud enterprise resource planning (ERP) system adoptions in Small- and Medium-sized Enterprises (SMEs) in literature. Cloud-ERP systems provide new opportunities for companies and make ERP systems more accessible to smaller companies beyond large enterprises (LEs). However, organizations are still experiencing challenges related to the adoption and implementation of cloud-based software and the use of new systems. Existing literature within this field of study mainly concentrates on the challenges of cloud-ERP adoptions in LEs. Relevant literature on the respective challenges experienced in SMEs is either relatively old or not addressing this topic exclusively. Hence, this research gap should be further studied to better understand and gain insight into the field. Based on the four phases of the Enterprise System Experience Cycle, we identify and classify the challenges addressing SMEs' cloud-ERP adoptions in extant literature.

Keywords: Cloud ERP; SMEs; Implementation; Adoptions; ERP Systems.

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Crime in the AEC-industry: Opportunity space for the quality assurer

Arnfinn Øversveen[a], Ola Lædre[a], Jardar Lohne[a]

[a]*Norwegian University of Science and technology (NTNU), Høgskoleringen 7A N-7491, Trondheim, Norway*

Abstract

The literature recognizes criminal behavior in the architecture, engineering and construction (AEC) industry as a growing problem that needs to be addressed. The purpose of this study is to identify the opportunity space a quality assurer (QA) has to commit work-related crime within Norwegian construction projects. The analysis focuses on the role in general and not individuals. Despite this, the methodological basis is based on a specific case. The project chosen can be representative of other Norwegian building and construction projects, and the insight are relevant to other contexts. The primary data is obtained through nine semi-structured in-depth interviews with key figures within the industry. Furthermore, a literature search has been carried out to identify knowledge gaps. The results identifies an opportunity space in a number of processes in which the QA is responsible. The QA has significant influence within projects and has the opportunity to manipulate the QA-systems to his advantage. Furthermore, there is little experience amongst the interviewees with this opportunity being exploited. The results from this study and published data support that a third-party control, distancing of bonuses and stricter sanctions will be the most effective measures. However, there are few comprehensive reviews of this research field to date. It seems that little research has been published on the topic of what opportunity space there is for a QA within AEC-industry. The article will help to identify discrepancies, knowledge gaps, deficiencies in routines, systems, controls and etc. Furthermore, the article can be used to improve the overall quality assurance.

Keywords: Transparency; Quality asssurance system; Work-related crime; Case study; Contractor.

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Decision making in Engineering Projects.

Zakari Tsiga[a], Michael Emes[a]

[a]*UCL Mullard Space Science Laboratory, Holmbury Hill Road, Holmbury St.Mary RH56NT, United Kingdom.*

Abstract

Even though risk management is a vital aspect of project management, the way that risk-based decisions are taken in projects is not well documented. Economic theory employs the concept of utility and assumes that decision makers are rational. Behavioural economics and prospect theory challenge this idea, making a number of specific claims about how decision-making behaviour deviates from rationality in practice. Based on a focus group discussion with project managers, this research highlights the importance of risk management in underpinning decision making and investigates the extent of rationality and applicability of prospect theory in an engineering project context. Prospect theory's claims of reference dependence and loss aversion are found to be important, but the claims of diminishing sensitivity and probability weighting appear to be less relevant.

Keywords: Decision making; Risk Management; Expected Utility Theory; Prospect Theory; Engineering Projects

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Definition of a technique for characterizing the expected benefits of a project

Pedro Cunha[a], Pedro Ribeiro[a]

[a]*Department of Information Systems, ALGORITMI Research Center, School of Engineering, University of Minho, Guimarães, Portugal*

Abstract

In the changing global economic landscape, it is vital for organizations to stay competitive and reduce their costs. Replacing outdated technology, improving business processes, and implementing new programs are some examples of activities that organizations have to do to face such demands. The increased pressure to create capital, business, and technology projects within budget, specifications, and schedule makes it necessary to avoid or at least soften risks and challenges that could compromise the desired outcomes of the project. So, it's each time more and more important to plan as much as it is possible to predict, including the benefits management. This paper aims to develop a proposition of a technique that allows the user to predict and monitor all inherent benefits to the conception of a project, aiding the work team in making decisions (especially about the feasibility of the project, or by other words, the go/no go decision), comparing projects and identifying optimizations opportunities.

Keywords: benefits management; go/no go decision; real environment.

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Do you really understand me? An analysis of cultural intelligence in global projects

Emma Kilduff, Kathryn Cormican

Enterprise Research Centre, School of Engineering and Lero – the Irish Software Research Centre, National University of Ireland, Galway

Abstract

Modern global leaders must be culturally intelligent to effectively operate in complex multicultural environments. While there is significant literature in place regarding cultural intelligence in global project management, there are several areas where our understanding remains limited. First, there is a lack of knowledge relating to the antecedents of cultural intelligence. Second, there is a lack of empirical studies capturing real-world data from industry relating to cultural intelligence in global projects. Third, it is unclear what correlation, if any, there is between leaders' characteristics and their level of cultural intelligence. To address these deficits, this study aims to identify the critical success factors (CSFs) for cultural intelligence in intercultural communication in the context of global projects and investigate the relationships between leader's characteristics and their level of cultural intelligence. Data were collected and analyzed from 85 project leaders currently working in a global multinational corporation (MNC) in Europe, Middle East, and Asia (EMEA). The findings confirm that emotional intelligence, personality, and openness to learning, communication and empathy are key to cultural intelligence in complex multicultural environments. The results advance our understanding of the antecedents to cultural intelligence and present actionable insights for companies.

Keywords: Cultural intelligence; project leaders; critical success factors; global teams, empirical analysis

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Early contractor involvement in the Valdres Project Delivery Model

Lium, Marius[a] , Wondimu, Paulos A.[a,b], Lædre, Ola[a]

[a]*Norwegian University of Science and Technology (NTNU), Trondheim, Norway*
[b]*Norwegian Public Roads Administration (NPRA), Norway*

Abstract

For years the need for road maintenance has been rising in Norway, and the Norwegian Public Road Administration (NPRA) has tried to find a solution. The Valdres model is a project delivery model developed by the NPRA for use in road refurbishment projects to utilize resources more effectively. By using early contractor involvement (ECI), the NPRA combines their own expertise with the contractors' buildability knowledge in the design phase to reduce risk and uncertainty with smarter and cost-reducing solutions. The studied pilot project E16 Fagernes-Øylo is chosen as case for testing the Valdres model. Ten semi-structured interviews with key informants have been carried out together with a document study to fill the knowledge gap regarding the Valdres model. The contractor was procured by a competitive dialogue (CD) before the final zoning plan was settled and has positively impacted on buildability and trust in the design phase. ECI was combined with Target Value Design (TVD) and Integrated Concurrent Engineering (ICE) to integrate lean thinking and enhance value creation in the design phase. This seemed to give fewer conflicts and cost reductions through a streamlined planning process. The studied case has experienced less changes and higher levels of cooperation with working towards the same goal in the construction phase compared to traditional project delivery models. Overall, the Valdres model has so far been a success.

Keywords: Early contractor involvement; Partnering; Competitive Dialogue; Target Value Design; ICE.

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Employee learning in the digitalization context: An evaluation from team members' and project managers' perspectives

Bertha Joseph Ngereja[a], Bassam Hussein[b]

[a] *PhD Candidate, Department of Mechanical and Industrial Engineering, NTNU, NO-7491 Trondheim, Norway*
[b]*Associate Professor, Department of Mechanical and Industrial Engineering, NTNU, NO-7491 Trondheim, Norway*

Abstract

The need for learning from individual level to organizational level is essential especially in the current era of digital transformation where adoption to new changes is unceasing. This is because if knowledge is fragmented in the organization, ideas, experiences, and solutions to problems will only be accessible to a certain group of people. The purpose of this study was to conduct an evaluation of the factors that facilitate learning in the digitalization context from the team members' and project managers' perspectives. Critical factors that facilitate learning in digitalization projects were identified from extant literature and categorized into employee, management, and environment related factors. These were evaluated using a questionnaire survey. A total of eleven measurement scales were established using a 5-point Likert scale. The survey was rolled out to 120 participants working in different digitalization projects in diverse industries. The results showed that, although the management related factors appear to have the most influence in facilitating employee learning in the digitalization projects, they are the factors that receive less attention in organizations compared to employee and environment related factors. Moreover, the study shows how management, employee, and environment related factors influence each other.

Keywords: learning; digitalization projects; top management; environment; knowledge

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Geographic Information System Usage Options in Facility Management

Lucie Vankova[a], Zdenek Krejza[a], Gabriela Kocourkova[a], Jan Laciga[a]

[a]*Brno University of Technology, Faculty of Civil Engineering, Veveri 331/95, 602 00 Brno, Czech Rebublic*

Abstract

This article deals with the possibilities of using Geographic Information Systems in the construction practice with a focus on the facility management of buildings. The aim is to present the usage options and advantages of the GIS in the construction industry resulting from its analytical and visualization capabilities. The article deals with current trends in construction, which very often use information databases with the location of information. Emphasis is placed on the area of facility management, for which, in the case of possible studies, a general structure of an information database usable for site management is proposed. A case study of the university premises with lecture halls, classrooms, laboratories, studios, staff offices, etc., was used to demonstrate the Geographic Information System usefulness in the construction practice. The aim is to present the purpose and the extent of what can be created for the comprehensive management of both exterior and interior areas of such premises. The article describes the process of designing a geoinformation database usable for facility management, which facilitates the user's orientation and work with information.

Keywords: Facility management, Geographic Information System, Case study, Usage.

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Government inter-organizational, digital transformation projects: five key lessons learned from a Norwegian case study

Kristin H.J. Hafseld, Bassam Hussein, Antoine R. Rauzy

Norwegian University of Science and Technology
Valgrinda 2000, S. P. Andersens vei, 7491 Trondheim, Norway

Abstract

The purpose of this paper is to gain knowledge about how to manage digital transformation projects in a government context. We analyze a government digital transformation project from its initiation to its end and reflect upon the process and the outcome. The case project did not achieve its intended objectives and therefore provided us with insights on contextual factors and decisions made that contributed to its failure. The results are presented as five key lessons learned. The lessons learned from the case study show that extensive focus on the technology, and selecting, and introducing the digital enabler, might have overshadowed other important concerns, such as early involvement of important stakeholder groups, and implementation of suitable technological platforms that would be fit for purpose to achieve the intended benefits for various stakeholder groups. Even though the intended e-services were not delivered as planned, the project organization learned a lot: in collaborating with government agencies representing different sectors, handling demanding financing schemes across sectors, and making decisions in a project regime that lacked sufficient governance structures.

Keywords: Digital transformation project; government; lessons learned; case study.

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Identifying Critical Success Factors in continuous improvement Projects in a steel company

FD Arnaiz, V. Alvarez, VR. Montequin,SM. Cousillas

Project Engineering Area, University of Oviedo, C/Idependencia 13,33004 Oviedo, Spain

Abstract

Quality management involves a constant effort of continuous improvement. Since continuous improvement actions are carried out uniquely, it is convenient to manage them as projects. Identifying the Critical Success Factors (CSFs) of continuous improvement projects and how they are perceived by the people directly involved in their management is of vital importance to be able to optimise human and material resources when prioritising actions and to be able to implement measures to ensure the success of these projects. Knowing the presence or absence of these success factors and how they are perceived within the organisation by those who manage them is an analysis tool that can be used by senior management to anticipate the failure of continuous improvement projects and to prioritise those factors perceived as weaker within the organisation. For this purpose, a structured survey was carried out with the managers of the continuous improvement projects to find out their opinion on which factors they believed to be most critical when developing these projects and to find out how often they thought they occurred in the past.

Keywords: continuous improvement; critical success factors; project team.

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Impact of the COVID-19 Pandemic on Construction Companies in the Czech Republic

Martin Nový[a], Jana Nováková[a]

[a]*Brno University of Technology, Faculty of Civil Engineering, Veveří 331/95, 602 00 Brno, Czech Republic*

Abstract

The global COVID-19 pandemic has been a part of our lives for the second year in a row and it has affected the activities of all economic entities across individual fields and industries. This article deals with research into the impact of the COVID-19 pandemic on construction companies in the Czech Republic. The research presented in this paper consists of several consecutive steps: designing a research plan, performing data collection and analysis and compiling research results. Qualitative approaches to data collection and evaluation, especially in-depth interviews and the coding method, were used for contextual understanding and comprehension of the situation in the companies under research. Open questions (topics) related to the respondents' experience, perceptions and opinions were created as a part of the preparation process. The aim was to obtain reliable and relevant answers to the questions asked. The research, which lasted for 5 months, involved 16 medium-scale and large companies from the Czech Republic. The aim of the research described in this article was to find out about the development of construction companies in the first half of 2021 and to specify their results in selected areas of activity.

Keywords: COVID-19 pandemic, construction industry production, Czech Republic, research into construction companies.

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Interlinking Sustainability in Organizational Strategy, Project Portfolio Management and Project Management; A Conceptual Framework

Gilbert Silvius [a,b], Carl Marnewick [b]

[a] *HU University of Applied Sciences Utrecht, the Netherlands*
[b] *University of Johannesburg, South Africa*

Abstract

The transition towards more sustainable business practices requires the changing of products, services, processes, policies and resources of organizations. Acknowledging the role projects play in these changes, the concept of sustainability should be integrated in the way projects are selected, prioritized, performed, managed, governed and evaluated. This requires the integration of sustainability in the organizational strategy, project portfolio management and project management. However, studies on sustainability in business describes the application of the concepts of sustainability mostly on the above-mentioned level in isolation, with little or no attention to the linkages between the strategy, portfolio and project levels. A conceptual framework is presented indicating the interlinking practices of integrating sustainability into the organizational strategy, project portfolio management and project management. From this framework, empirical studies can be developed, and guidance is provided for organizations that aim to improve this integration and thereby embedding the deeper implementation of sustainability into their policies and practices.

Keywords: Sustainability; Project Portfolio Management; Project Management; Organizational Strategy.

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Key Performance Indicators (KPIs) for measuring PMOs Services in selected Organisations in Botswana

Ntshwene, K[a], Ssegawa, J.K[a], and Rwelamila, P.D[b].

[a]*Department of Civil Engineering, Faculty of Engineering and Technology, University of Botswana, P. Bag 0061, Gaborone,*
[b]*Graduate School of Business Leadership (GSBL), University of South Africa (UNISA), P O Box 392, UNISA 0001, Pretoria. South Africa.*

Abstract

Project management (PM) has been adopted by both public and private organisations in two stages. The first stage, related to the acquisition of the competence by individuals working is disparate corners of an organisation. In this configuration, skills have been used in an uncoordinated manner to support and provide PM services. However, in the past decades, most organisations, including many in Botswana, have moved to a second level of establishing and operating project management offices (PMOs). The purpose of PMOs is to provide and support managerial, administrative, training, consulting, and technical services for projects in organisations. Therefore, PMOs are expected to provide value-for-money by increasing the success of project delivery i.e., within time, budget and as specified. To know that this is being attained requires measuring results from the services offered by PMOs using key performance indicators (KPIs). This article, therefore, discusses results of a study that sought to identify the KPIs used in measuring PMO services in six selected organisations in Botswana. The research was based on two methods namely a questionnaire and focus group discussion workshops. The strategy was that if respondents indicate in the questionnaire that they measure results of their PMO services, then they would indicate in the focus group discussions the nature of their KPIs. Disappointingly, results indicated that five organisations (OrgA, OrgB, OrgC, OrgD and OrgE) did not have formal measurement regimes and hence no KPIs were identified. Only one organisation (OrgF) indicated some form of performance measurement based on the balanced scorecard of the PMO.

Keywords: KPI, PMO, Perfromance Measurement, Project Based Organisation, Project Office, Construction, Botswana.

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Lean construction management techniques and BIM technology – systematic literature review

Adrian Michalski[a], Eryk Głodziński[a], Klaus Böde[b]

[a]*Warsaw University of Technology, Poland,*
[b]*Bauhaus-Univeristät Weimar, Germany*

Abstract

For the last years lean construction (LC) and Building Information Modeling (BIM) are perceived as important application and research fields. Numerous publications discuss various aspects that need systematization and require further thought related to benefits and threats for an organization. The paper presents systematic literature review that indicates hot topics in scientific studies, such as: benefits related to join use of LC and BIM, issues related to simultaneous implementation and utilization of LC and BIM, instruments supporting implementation and utilization, potential future application.

Keywords: lean construction; BIM; systematic literature review.

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Learning Project Management. The case of further education in Norway

Tina Åsgård

Western Norway Universit of Applied Sciences (HVL), Postboks 7030, 5020 Bergen, Norway

Abstract

To succeed in the international labor market, the competence of the workforce is crucial. The need to continually update competence has put life-long learning to the top of the political and research agenda internationally, and higher education plays a key role in the effort to manage this challenge.
As working life is changing rapidly, so must businesses and the public sector. In a wide range of organizations and industries, project work is now a common practice and a main catalyst for change. Hence, competence in project management is highly wanted, and has resulted in many courses offered by higher educational institutions.
This paper examines the spreading of further education courses on project management and project work offered by public higher educational institutions in Norway. The focus is on which professional fields dominate the teaching of project management and what forms of learning they apply. The study maps the extent to which student active learning is implemented in the course design by looking at which methods of assessment are utilized.
The findings show that the professional fields of business administration as well as engineering and technology dominate teaching in project management and project work. There are also indications of widespread use of student active learning in courses of project management, although it is not consistent and how it is implemented in practice needs further investigation.

Keywords: adult learning, further education, project management, student active learning.

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Findings and improvement opportunities from a case study

Ulrik Hansen[a], Roar Fosse[b], Ola Lædre[a]

[a]*Norwegian University of Science and Technology (NTNU), 7491 Trondheim. Norway*
[b]*Skanska AS, 0187 Oslo, Norway*

Abstract

Norwegian contractors are more involved in design management than before due to an increased number of design build contracts, and they continuously improve their design management processes. In 2018, the Norwegian Consulting Engineers' Association launched the Model Maturity Index (MMI) for BIM to support planning and control of design management. This study assesses how MMI, project sectioning, delivery lists, scheduling and follow-up procedures can improve design management processes.
After an initial literature review, qualitative data from a case was collected by semi-structured interviews with the design manager and six designers. Observations in sixteen design meetings and a document study were used to supplement the data from the interviews. The case study revealed that MMI was used to control achieved maturity for each discipline BIM model rather than for design planning. Geographical zones and discipline models – not technical systems – were used to create an overview of necessary design tasks, and the zones gave a structure for design meetings. It was neither created delivery lists for the individual disciplines, nor schedules with delivery milestones – despite recommendations in literature. As a result, the case project strived with planning the maturity level for the involved disciplines' BIM and follow-up on the design process. Recommendations on how the MMI-framework should be used in future projects are identified. For example, some improvements of coordination between MMI300 and MMI350 are suggested. Future projects should explicitly consider both geographical zones, technical systems and discipline models when creating MMI plans. Future projects should also support MMI plans with delivery lists containing tasks and milestones for each maturity level for each discipline model. Finally, the design manager should re-plan MMI-related tasks and milestones not reached in a Plan-Do-Check-Act related manner during design.

Keywords: Model Maturity Index; MMI; design planning; design management.

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Multiple Linear Regression Model for Improved Project Cost Forecasting

Filippo Maria Ottaviani[a], Alberto De Marco[a]

[a]*Politecnico di Torino, Corso Castelfidardo 39, Torino 10129, Italy*

Abstract

Several studies have been conducted in the Project Management field further to improve the Earned Value Management (EVM) methodology to forecast the project cost estimate at completion (EAC). This work aims at developing a linear model to increase the accuracy of the standard EAC and minimize the variance of the error. The research is conducted on an EVM data set comprising 29 real-life projects for a total of 805 observations. Multiple linear regression analysis is performed to evaluate the number of regressors, the priority of the candidate EVM variables into the regression model, and to assess the diagnostics of the model fit. The new EAC formulation is benchmarked, the results show the model to provide higher accuracy and lower variance compared to the standard formulation.

Keywords: Earned Value Management; Estimate at Completion; Linear Regression.

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Opportunity Space for Work-related Crime from Procurement to Production

Amalie Steen Selvik[a], Maren Mikaelsen Edvardsen[a], Ola Lædre[a], Jardar Lohne[a]

[a] *Departement of Civil and Environmental Engineering, Norwegian University of Science and Technology (NTNU), 7491 Trondheim*

Abstract

This study examines the opportunity space for work-related crime from procurement to production in the Norwegian construction industry through the optic of sixteen measures. This study was initiated by literature review about work-related crime in construction industry. Further, the method consists of a case-specific document study and interviews. Eleven semi-structured interviews were conducted with representatives working within two contractors. Research on the measures in context of the Norwegian construction industry is scarce. The results provide a perception of the contractor's routine regarding the measures. A majority of the measures are used in both procurement and production phase. However, use of them differ, in both companies and phases. This creates an opportunity space to the measures. The main reason for the opportunity space is lack of control and discontinuity of responsibility. The transition between phases is essential to keep control and continuity. There should be more research on counteracting measures in the Norwegian context. There is need for industry efforts to improve barriers to avoid crime. The study shows an opportunity space for work-related crime in transition from procurement to production. Thus, more research on the transition between the phases is needed. This study provides assessment of the implemented measures.

Keywords: Construction industry; measures; production; procurement; counteract; contractor; subcontractor; transition.

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Optimal time for contractors to enter infrastructure projects

Freddy Antonsson[a], David Lindvall[a], Johan Lagerkvist[a], Rasmus Rempling[a]

[a]*Chalmers University of Technology, Department of Architecture and Civil Engineering, Göteborg, Sweden*

Abstract

The design- and construction stage of large construction projects are often two separate fragmented processes. Early contractor involvement (ECI) is a project delivery method where the goal is to include construction knowledge into the design phase. This is done by procuring the contractor during the design phase of a project. There are different approaches to which time the contractor is introduced. This research paper aims to investigate the optimal time for contractors to enter infrastructure projects. In order to do this, an empirical study was conducted, where interviews were held with nine representatives from an ongoing ECI project in Sweden. The studied project was procured by the Swedish Transport Administration, and the contractor entered the project at the beginning of the design phase, before a land acquisition plan had been developed. This is the first time in Sweden that a contractor has been procured this early in a road project. The findings from the interviews show that responsibility, understanding, innovation, risk management, relationship-building and implementation are the aspects that have been affected due to ECI. By analyzing and discussing the results, it was concluded that involving the contractor as early as in the studied case has been beneficial, and that involving the contractor as early as possible in infrastructure project is favorable.

Keywords: ECI, timing, collaborative management method

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Over time or on time? A study of delays in large government projects

Morten Welde[a] and Ingri Bukkestein[a]

[a]*NTNU – Norwegian University of Science and Technology, 7491 Trondheim, Norway*

Abstract

This paper investigates the extent of delays in large government investment projects in Norway. We use a data set consisting of 112 road, railway, building, defence and ICT projects. All projects have been planned and implemented within a standardised governance framework. This ensures a more robust assessment of causation compared to studies that use data from disparate projects around the world. The results have shown that about half of the projects are completed on or before time, there are a large proportion of projects that are severely delayed. Defence projects are particularly prone to problems during their delivery. This is in accordance with findings from other countries. The paper shows that there has been a slight improvement in time, that is, the extent of delays seems to have been reduced over the last 20 years. Counter to expectations, projects that are delayed do not seem to be more at risk to overrun their costs.

Keywords: Schedule delay; overruns.

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Project management in office: BIM implementation

Alcinia Zita Sampaio[a]

[a]*University of Lisbon, Higher Technical Institute, Dep. Civil Engineering, Av, Rovisco Pais, Lisbon, Portugal*

Abstract

Building Information Modelling (BIM) methodology is increasingly finding acceptance in all sectors of the construction industry including, as a first step, the architectural design, and after a set of multi activities concerning civil engineering (structures, building, budgeting, maintenance or operation). The elaboration of a complete project requires a BIM multi step workflow, including modelling, analysis, and the optimization of the final product that must be coordinated by a BIM manager. This new function within an enterprise, office or in single project is essential in a BIM context, as the main concept of the methodology is the centralization of all the information obtained throughout the elaboration of a complete project. The main competencies of a BIM manager: to deliver responsibility between all professional involved in a project; to authorize each expert to develop, change or transfer its project component; to indicate and control the level of information that a BIM model must include according to the Level of Development or Detail (LOD) established for each step of the project. The level of maturity of an enterprise or office is, in part, evaluated in a base of the integration of processes, using adequately the available BIM platforms, and in the level of collaboration established between the team regarding all the project process. The maturity achieved around the world is supported on governmental policies adopted by each country, in a mandatory or progressive way. The aspects related to the maturity achieved in an enterprise and the efficiency of the BIM manager work are the main objectives focused in the text. Several remarks were workout and presented, as a positive contribution to the dissemination of the BIM implementation in the sector.

Keywords: BIM methodology; Concept; Implementation; BIM manager; Maturity.

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Project management maturity in the biotechnology industry

Micaela Martins [a], Cláudia Sousa e Silva [b], José Magano [c]

[a]*Univesity of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[b]*Research Unit on Governance,Competitiveness and Public Policies (GOVCOPP), DEGEIT, Univesity of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[c]*Research Center in Business and Economics (CICEE), Universidade Autónoma de Lisboa, Rua Sta. Marta 47, 5.º Andar, 1150-293 Lisboa, Portugal*
[c] *ISCET-High Institute of Business Sciences and Tourism, Rua de Cedofeita, 285, 4050-180 Porto, Portugal*

Abstract

This paper contributes to the development of project management in companies that integrate biotechnology in their processes, given the increasing importance of this sector under the current context. The main goal is to assess project management maturity in a sample of companies that involve biotechnology processes, identifying their main weaknesses and strengths in project management. A quantitative approach was applied by analyzing the data collected through a questionnaire structured with the K-PMMM Level 2.
This work allowed to diagnose 96 companies of this emerging sector, still scarcely studied as concerns project management. All participating companies recognized the importance of project management, however there are still several steps to consolidate the evaluated project management practices, once only about 12,5% reached the whole five life cycle phases of project management maturity.
The originality of this work relies on the structure of the data analysis that allowed to highlight the multidimensional and simultaneous perspective of the project management maturity process. That is, a process that recognizing the need and added value of project management, implementing methodologies and tools, and having the executive and line management support. These factors must be taken care of in parallel to evolve the organization´s capacities to manage its projects consistently and long term. The study revealed that part of the participating companies meets this simultaneous multidimensional approach, although still very incompletely.

Keywords: Project management maturity; Biotechnology project; life cycle phases of project management maturity.

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Research approaches in opportunity management: scoping review

Andrei Marsov[a], Nils O.E.Olsson[a], Ola Lædre[b]

[a]*Department of Mechanical and Industrial Engineering, Faculty of Engineering, Norwegian University of Science and Technology, Richard Birkelands vei 2B, 7491 Trondheim, Norway*
[b]*Department of Civil and Environmental Engineering, Faculty of Engineering, Norwegian University of Science and Technology, Høgskoleringen 7a, 7491 Trondheim, Norway*

Abstract

It is believed that project management practitioners perceive risks as threats and do not pay enough attention to the upside effects that they may pose. Opportunities may emerge along the project lifecycle accounting for significant time and cost savings and be lost if left unnoticed. Thus, the management of positive risks deserves serious attention from researchers and practitioners within project management. The purpose of this literature study is to identify how researchers formulate their problem statements and which common research methods are applied to investigate positive risks at the project level. The study findings reveal that most publications are related to the practical aspects of opportunity management, representing a track-bound research approach with few articles that challenge the commonly accepted assumptions and how the management of positive risks is being performed on projects. Applied research methods in opportunity management confirm the complex nature of positive risks that demands a longitudinal method approach. The study results may be of interest to the scholars who intend to conduct further research on uncertainty and risk management.

Keywords: opportunity management; positive risks; scoping review; research methods; research questions.

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Risks of Data Science Projects - A Delphi Study

Cristina Varela, Luísa Domingues

Instituto Universitário de Lisboa (ISCTE-IUL), ISTAR, Lisboa, Portugal

Abstract

Risk is one of the most crucial components of a project. Its proper evaluation and treatment increase the chances of a project's success. This article presents the risks in Data Science projects, assessed through a study conducted with the Delphi technique, to answer the question, "What are the risks of Data Science projects". The study allowed the identification of specific risks related to data science projects, however it was possible to verify that over a half of the most mentioned risks are similar to other types of IT projects. This paper describes the research from expert selection, risk identification and analysis, and the first conclusions.

Keywords: Data Science, project sucess, project risk management, risk assessment, Delphi study.

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Significance of the contractual relationship for the efficient railway maintenance project planning

Daria Ivina[a], Nils O.E.Olsson[b], Lena Winslott Hiselius[a]

[a]Department of Technology and Society, Lund University, P. O. Box 118, 22100 Lund, Sweden
[b]Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Richard Birkelands vei 2B, 7491 Trondheim, Norway

Abstract

Efficiently planned railway maintenance helps ensure reliable infrastructure and the proper functioning of its components. The Swedish Transport Administration delegates maintenance work to contractors through a tender process. This paper analyses differences in communication and collaboration in the planning and execution of maintenance under two contract types. A document review and interviews with 22 project managers identifies issues in planning and scheduling related to knowledge transfer at contractor companies, booking time for maintenance and lack of trust between contractors and the client. The results show how the two types of contracts are perceived differently by the parties to the contracts.

Keywords: railway; contract; maintenance projects; planning; communication.

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SMEs, Barriers and Opportunities on adopting Industry 4.0: A Review.

Hussein Magdy Elhusseiny[a,b], José Crispim[c]

[a]*Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal.*
[b]*Arab Academy for Science, Technology and Maritime Transport, College of International transport & Logistics, Alexandria, Egypt.*
[c]*NIPE, Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal.*

Abstract

Industry 4.0 (I4.0) enables SMEs to enhance their manufacturing capabilities and compete globally through the deployment of cutting-edge technologies. This review identifies the barriers and opportunities of adopting industry 4.0 in the manufacturing sector in developed vs. developing countries. In total, 54 studies met the screening criteria. The synthesized factors were classified into dimensions to helps the understanding of what type of difficulties SMEs face in the transition to the 4.0 generation. This study found that developing countries face more barriers but also perceive more opportunities in relation to industry 4.0. Organizational barriers and technical Barriers have been the main types of barriers studied in both sets of countries. In terms of benefits, studies have emphasized 1) gains in terms of operations management, and 2) questions related to market, sustainability and supply chain management.

Keywords: Industry 4.0, SMEs, Manufacturing, Barriers, Opportunities.

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Socio-Economic Impacts of Occurrences on Railways

Vít Hromádka[a], Jana Korytárová[a], Eva Vítková[a], Herbert Seelmann[a], Tomáš Funk[a]

[a]*Brno University of Technology, Faculty of Civil Engineering, Veveří 331/95, 602 00 Brno, Czech Republic*

Abstract

The paper presents partial outputs of an applied research project aimed at evaluating the socio-economic impacts of occurrences emerging on the railway and their reflection into the economic evaluation of railway construction projects. The article builds on the research results presented within previous scientific articles where the unit impacts of sub-categories of occurrences on the Czech railways were determined using a detailed Database of Occurrences for the 2011-2018 period. These impacts were related both to one railway station and one kilometre of the wide line for the occurrence sub-categories. The values obtained were subsequently verified on case studies of specific railway infrastructure projects implemented in the Czech Republic. The results of the case studies raised the need to create an alternative methodology for the evaluation of socio-economic impacts, which would more accurately reflect the real situation on the railway. The aim of the paper is to modify the originally designed methodology for evaluating the socio-economic impacts of occurrences into a new methodology, which would relate the impacts of occurrences only to a standard kilometre of wide line, i.e. without taking account of separate impacts of occurrences on one railway station. The proposed methodology was verified on a case study, which compares the real values of socio-economic impacts emerging on the railway in the period under research, the values determined using the original methodology and the values determined according to the newly modified methodology.

Keywords: Economic evaluation; Railways; Occurrences; Cost-Benefit Analysis; Impacts.

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Student peer mentoring in an entrepreneurship course

Kari Håvåg Voldsund, Judit Johnstad Bragelien

Western Norway University of Applied Sciences, Postboks 7030, 5020 Bergen, Norway

Abstract

Innovation and entrepreneurship are two important drivers for growth, productivity and to welfare development. Companies, organizations, and governments increasingly focus on these topics, and academia has a central role in the Triple helix. Entrepreneurship education is considered an important contributor towards beforementioned goals. Active- and experiential learning has proven a wide range of benefits in entrepreneurship education, with more guidance. Student peer mentoring is regarded as an effective intervention to establish goal-oriented success and retention of students. By combining these two concepts, we try to create an educational setting for effective "real life" entrepreneurial learning through projects. The aim of this paper is to (1) Briefly describe the pedagogical design and the project introducing student peer mentoring in an entrepreneurship course; and (2) Study students' experience and the change in academic results introducing student peer mentor services. This paper has an explorative design, and we conduct a comparative case study. The course is ING101 Technology Management, Economics, and Innovation (ING101) at Western Norway University for Applied Science (HVL). ING101 is for non-business students at the undergraduate level. The main tasks for student peer mentors are to facilitate student's team-processes and academic work with a demanding semester-assignment where they create a business plan. Using student peer mentors in ING101 shows results. Firstly, students monitored by the student mentors, covers a role the lecturer does not cover due to (1) Age difference, and (2) Lecturer will grade the students and students may be reluctant to ask questions. Secondly, the use of student peer mentors has resulted in decreased reported workload and increased mastery. Thirdly, the average grade performance seems to have improved. These findings may be helpful for future empirical studies of mentoring in entrepreneurship education and serve as a guide for other who experiment and implement different mentoring styles in innovation and entrepreneurship courses.

Keywords: Innovation; entrepreneurship; experiential learning; project; teamwork; peer mentoring.

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Synergy between Traditional, Agile and Lean management approaches in construction projects: bibliometric analysis

Abdallah Lalmi[a], Gabriela Fernandes[b], Souad Sassi Boudemagh[a]

[a] *University of Constantine 3, Faculty of Architecture and Urban Planning, project management department, AVMF laboratory, 25000, Constantine, Algeria*
[b]*University of Coimbra, CEMMPRE, Department of Mechanical Engineering, Polo II, Coimbra, 3030-788, Portugal*

Abstract

This research aims to contribute to the development of knowledge in project management, by searching for management approaches that can be useful in construction projects. A bibliometric approach based on quantitative analysis methods was applied to investigate the synergy between Traditional, Agile, and Lean management approaches. This study also evaluates the status of the three different approaches using a visualization analysis of journal articles. The bibliometric study was developed with a portfolio of 200 papers around "synergy between Traditional, Agile and Lean approaches" collected at the Web of Science database, covering the evolution of this topic over the last ten years (from 2011 to 2020). The retrieved records were analyzed in terms of year of publication, country, subject, and keywords. The analysis of the original articles revealed that the total number of publications has continuously increased over the last few years. The country producing more papers on this theme was the United States followed by England and Germany. Few studies in the literature have discussed this theme in the construction industry, which means that the concept of combining Traditional, Agile, and Lean approaches is a new concept in construction projects.

Keywords: Agile approach; Traditional project management approach; Lean approach; Synergy; Construction projects; Bibliometric analysis.

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The Network Entropy as a Measure of a Complexity for Project Organizational Structures

J.R. San Cristóbal

University of Cantabria. Spain. jose.sancristobal@unican.es

Abstract

The selection of an organizational structure is one of the most important decisions to make when executing a project. The form of the structure will define the authority, the relationships between the members of the project, where each member is located, the lines of coordination, control, etc. There exists a wide array of quantitative metrics that may be used to measure the complexity of a project organizational structure and that are borrowed from other fields. In this paper, we adopt a metric developed from Shannon's information entropy, the network entropy, which is a useful metric to measure the complexity of a project organizational structure linking the complexity of the structure to its functional role. The measure is applied to the project organizational structure of an international company dedicated to the development, construction, and operation of renewable energy projects in Europe, Asia, and America. Additionally, and for comparative purposes, alternative organizational structures are considered for the company. Our results show that adopting an organizational structure different from the structure that the company is currently using, the company would reduce its complexity and improve its structural agility and performance.

Keywords: Network Entropy; Project Management; Project Organization as Structures

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The role of the PMO in enforcing and standardizing attendance to the needs of software project teams by project managers

Robert Hans[a], Ernest Mnkandla[b]

[a]*Computer Science Department, Tshwane University of Technology, Soshanguve South Campus, Pretoria 0152, South Africa*
[b]*School of Computing, University of South Africa, The Science Campus, Florida, 1710, South Africa*

Abstract

Despite their critical role in project success, software project teams (SPTs) remain the most neglected key stakeholder group by software project managers (SPMs) and researchers in the project management field. The needs and interests of SPTs have not received due attention from SPMs. As an attempt to address the neglect of SPTs by SPMs, the authors of this study developed a model aimed at assisting SPMs to pay necessary attention to the needs of their project teams. Key to the function of the model is the project management office (PMO), which is aimed at enforcing and standardising the collection and addressing of SPT members' views and concerns. The PMO as a custodian of project management practices in an organisation, is responsible for standardising and enforcing project management practices across the enterprise. The purpose of this research study is to explore how the functions of the PMO can be used to operationalise the enforcement, institutionalisation and standardisation of the overall function of the model. Given the practical orientation of this study, pragmatic and interpretive research paradigms were deemed appropriate for application. Using interpretation, various suitable PMO functions as determined from project management literature were used to meet this study's objective. Future studies should include the validation of the practicality of this paper's assertion in a real-life project environment.

Keywords: software project; project management office; project team; project manager; enforcement; standardisation; model.

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What promotes motivation and learning in project management students?

Hilde Nordahl-Pedersen[a], Kari Heggholmen[b]

[a]*Norway School of Business and Economics, Campus Harstad, The Arctic University of Norway, 9480 Harstad*
[b]*Western Norway University of Applied Sciences, Postboks 7030, 5020 Bergen*

Abstract

This article discusses what promotes motivation and learning in students of project management. It is based on a qualitative study with six students from different project groups at a higher education institution in Norway. The study shows that ownership of self-chosen projects and regular feedback from the supervisor lead to hard work, intrinsic motivation and learning in all phases of the project. Participation in project groups with considerable autonomy within a tight framework creates positive communities of learning and experiences of flow. Presenting interim status reports to the class in combination with final written and oral assessment leads to competition between the project groups and extrinsic motivation to perform best, which results in deep learning. The study shows that project-based teaching is an important tool to encourage student motivation and learning.

Keywords: Project-Based Learning, Motivation, Students in Higher Education.

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The Effectiveness of Managing Lessons Learned from Projects in Selected Organisations in Botswana

Ssegawa, J.K[a] , Chika, P[a]. and Ntshwene, K[a]*

[a]*Department of Civil Engineering, Faculty of Engineering and Technology, University of Botswana, P. Bag 0061, Gaborone.*

Abstract

Poor project delivery has been reported in many parts of the world. In addition, the causes of such poor performance have been identified and are often reported to recur from one project to another in most organisations. Based on that observation, one would wonder if organisations use lessons learned from past projects to improve the performance of subsequent project delivery. This article discusses findings of a study that investigated the effectiveness of managing lessons learned from past projects based on two purposely selected organisations in Botswana. A multi-methods approach involving a questionnaire, focus group discussions and interviews, was used to collect triangulated data for investigating the phenomenon. The findings indicated that majority of lessons learned are derived from an informal process often based on recollection of experiences by project team members. Essentially in the two organisations studied, the lessons learned process is not effectively managed. Barriers to effective management of lessons learned emanate from lack of institutionalisation of the process where its value is not articulated and supported by management. This deficiency cascades to the operational level where project teams do not conduct tasks required to effectively manage lessons learned during implementation and at the end of the project due to lack of time or due to the need to move to new projects. Despite the inherent limitation of studying two organisations, the findings provide an insight to extent to which lessons learned are used in implementing projects and supported by similar findings from literature.

* Corresponding author. Tel.:+267 355 4292; Fax: +267-3952305.
E-mail address: ssegawaj@ub.ac.bw or projecticame@gmail.com

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Keywords: lessons learned, project evaluation, knowledge management, project closure, project expriences

1. Introduction

It has been reported by a number of literature sources (e.g. that often projects encounter performance difficulties, either in terms of project management success (efficiency), project success (effectiveness), or both. In an organisation, a review of why a project failed may indicate that the causes are not new but have occurred in the previous projects. This would strongly suggest then that past lessons were not learned and hence used to inform subsequent project delivery. Lessons learned describes a deviation (whether positive or negative) from the expected norm resulting from a project decision, activity, process or a combination of them. Deviations have the value of highlighting opportunities for continuous improvement [1]. Therefore, regardless of whether the project experiences were positive or negative, both should be effectively managed. This enables project implementers to discard practices that did not work while carrying forward and reinforcing those which fostered good outcomes on subsequent projects. While the use of lessons learned is a noble and logical idea, research studies have reported that its uptake during project implementation is not as high as touted. A 2007 study by Ernst & Young, as cited by [1], for example, noted that 91% of the project leaders who participated in its study believed that lessons learned from projects was important. However, 13% said their organisations conducted process on all projects and in addition, only 8% believed that the primary reason for undertaking the process was for organisations to benefit from the knowledge harnessed. This should be a worrying finding for the project management fraternity.

It is critical to learn from past project implementations so that expensive mistakes do not occur in the future [2]. Using lessons learned avoids inventing the wheel and hence reduces the project management learning curve, as each time a project is implemented it builds on the previous knowledge. In so doing, effective management of lessons learned improves the project management performance in terms of saving costs, managing project schedules and avoiding repeating the same mistakes through risk mitigation ([3], [4]). Furthermore, lessons learned are often lost when projects are completed and the team is disbanded, unless considerable effort is made to capture this valuable information [5]. It was noted [6] that even when lessons learned are captured during project reviews, they are often poorly formulated, insignificant, not replicable and sometimes invalid. Furthermore, most often they are neither communicated, shared with future project leaders nor are they accessible and hence rendering the process of capturing lessons learned futile. Yet in all project cases people, strategy, technology and management are important for project success [2].

Given that background, a sustained process that allows the effective management of lessons learned is critical to organisations. This article reports findings of a study whose objective was to assess level of effectiveness in managing lessons learned from projects in two selected organisations in Botswana.

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The research was motivated by the notion that the project management regime in Botswana was viewed as deficient as reported by various sources (e.g. [7], [8], and [9]). The assumption was that possibly the ineffective management of lessons learned by project implementing organisations could be a contributing factor. The article is divided into five major sections including the introduction. The next section briefly reviews literature relating to the management of lessons learned. The third section outlines the methodology used in investigating the effectiveness of lessons learned in the two case studies while the fourth section presents results and a discussion of findings. The paper ends with a conclusion and possible implications of findings on project management.

2. Literature Review

While there is no precise definition of lessons learned in literature one is worth considering due to its simplicity. Lessons learned is the knowledge gained from experiences, successful or not, for the purpose of improving future project performance [10]. Although projects are deemed to be unique endeavours [11], they have recurrent themes which can be extrapolated from one project to another and hence the importance of lessons learned. It is for this reason that the ILO [6] noted that though lessons learned from projects may be specific and in well-defined situations, they are intended to be significant, relevant to a wider context (i.e. generalizable) and replicable.

Furthermore, lessons learned process takes place at any point of the project life-cycle [4]. On the other hand lessons learned involve formal and informal practices [12]. In addition, the lessons learned process takes place at individual, project team and organization level and normally culminates in both explicit and tacit knowledge ([13], [14]). Lastly, there are two critical aspects relating to effective management of lessons learned namely (i) nurturing an enabling environment and (ii) developing the value chain of the lessons learned process as illustrated in Figure 1.

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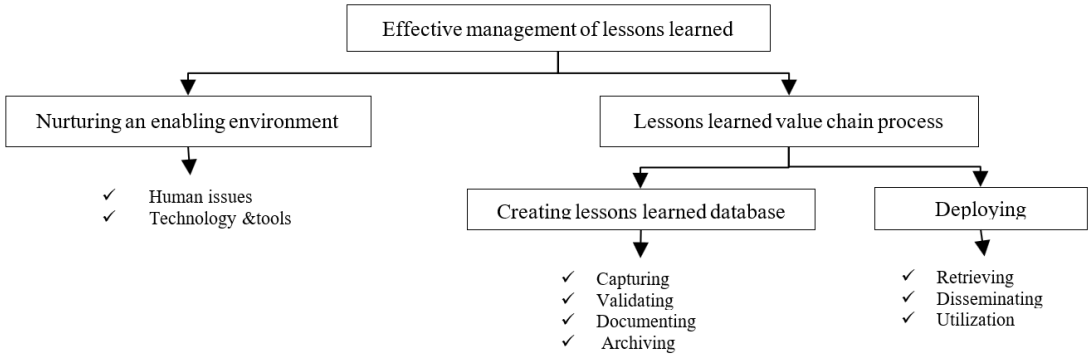

Figure 1: Factors for effective management of lessons learned

2.1. Creating an enabling environment

An enabling environment must exist for an organisation to harness the power of lessons learned. Scholars (e.g. [15], [16], [17]) have identified two major environmental factors, which if not attended to, may become major barriers to effective management of lessons learned, namely human and technology issues.

Human issues pervade the landscape for effective management of lessons learned. First, leadership involvement, commitment and support are key to the effectiveness of managing lessons learned ([18], [19]). A strategic approach is needed where management articulates the value of lessons learned by emphasising that if it is well managed it becomes part of intellectual property that contributes to creating a competitive advantage for the organisation. It is only through this belief that the process may cascade to the operational level. To reinforce this belief management needs to define roles and responsibility for managing the lessons learned process including providing the necessary resources [20]. Second, an organisation must adopt and develop a culture of learning, characterised by an environment of willingness to speak about difficult issues; admission of the existence of a problem; encouraging the sharing of 'bad news'; breaking down organisational 'silos'; and reinforcing effective communication and cooperation among departments and stakeholders [16]. Third, attitudinal issues must be positively dealt with which may be manifest in form of individuals or groups that are unwilling to learn from their mistakes; young project managers being overconfident and reluctant to take advice from seniors; and the other way round where seasoned project managers are unwilling to pass on their expertise to their juniors, preferring to hoard their knowledge and experience. Fourth, lessons learned process must be institutionalised such that project managers and their team have in-built time for the process. A number

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of studies (e.g. [21], [22]) have identified causes of lack of time as arising from project teams being engaged in multiple projects; pressures to deliver under tight project schedules; high time pressure towards the end of a project that does not allow the capturing of lessons learned as new tasks already await the project teams. Furthermore, project teams sometime are not motivated to manage lessons learned because there is no incentive to do so, perhaps due to the process being viewed as a pathological one which 'digs up past dirt'. Lastly, the inexistence or inability to harness technology in managing lessons learned can be a deterrent. Technology is a powerful tool in the processes of creating, disseminating and utilising lessons learned to achieve successful project implementation. Its reliability, accessibility and user friendliness are key attributes in the effective management of lessons learned.

2.2. Managing Lessons Learned

As already noted lessons learned process may be informal or formal. In the informal set-up, lessons learned are normally captured by an individual or group of individuals who need to recollect their project experiences. The major drawback of this method is that those who were not part of the experience may not access these individuals. Poor recollection, transfers, retirements, resignations or even deaths may hamper this 'the human repository' based method. Therefore, effective management of lessons learned requires developing a formal method that consists of two tasks creating a lesson learned database and deployment of lessons learned.

Creating lessons learned data base

Creating lessons learned data base requires number of tasks that include capturing, validating, documenting and archiving ([1], [23], [24], [25], [15]). Capturing lessons learned is the actual identification and recording of what a project team considers a deviation from the norm, a positive or negative project experience. This process requires planning a specific workshop or to be part of an end-of project review. A workshop requires scheduling and formulating objectives for the workshop; inviting the relevant participants; appointing a facilitator and recorder; availing workshop resources; and creating an enabling atmosphere where people are free to express themselves. The implementation part deals with what to record as lessons learned [26]. Scholars (e.g. [27],[28], [10], [25]) suggested the following steps: (i) identify the theme to form lessons learned (e.g. bid evaluation, adhering to project schedule, managing claims of extension of time, stakeholder or scope change management); (ii) describe the background of working context of the theme i.e. where, when, who and how did it occur; (iii) describe what went wrong or what went right; (iv) identify what was the root cause or what enhanced the issue (the 'why'); (v) what can be learned, and (vi) what should be done next time to avoid what went wrong or to sustain what went right.

During the workshop, it is possible to get a myriad of lessons learned some of which may be trivial, misconstrued or even untrue. A lessons learned could be a subjective issue and hence some form of

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validation is necessary to avoid biased opinions of individuals. The validation process ensures that accuracy, consistency and relevance are maintained [11]. It requires corroborating, analysing testimonies and comparing them with expectations (e.g. based on laws, policies, standards and best practices) to identify where there was significant adherence or deviation. It may require a couple iterations with workshop participants to come to some consensus on what to finally document.

Lastly, once an experience is considered worth recognising as a lessons learned, it is documented in some form of lessons learned database, be it manual or electronic (of which the latter is preferred). This step requires agreeing on the themed title, indexing code, format and storage medium to provide easy access and retrieval.

Deploying lessons learned

Archived lessons need to be retrieved or disseminated before being utilise ([23], [24], [25], [15]). Prospective users can retrieve lessons learned in a passive or proactive mode [29]. In the passive mode the lessons learned are broadcast to either all members of the organization or to a dedicated list of individuals. In the proactive mode a system analyses the user's recent events, predicts the required lessons learned themes and sends them to the individuals proactively based on the analysis.

Utilisation is the most important aspect in managing lessons learned since if lessons learned are not utilised there is no value in capturing them. Consequently, there is no learning from past experience, good or bad. As already noted while project implementers are responsible for utilising lessons learned, management must create and promote an atmosphere for their utilisation.

3. Methodology

The case study research strategy was used in the study. Research involving a case study may be viewed as an investigation into single or multiple instances of an observable complex phenomenon that is constrained by clearly identifiable boundaries [30]. Two organisations (for anonymity referred to as OrgA and OrgB) were conveniently selected based on management's willingness to allow the study to be conducted within their ambit coupled with fact that they had implemented a number of projects in the past. The next sections describe the profile of the two cases and how data was collected to assess the effectiveness of managing lessons learned.

3.1. Profile of the Case studies

OrgA is a state owned enterprise in the tourism sector while OrgB is a semi-state owned organisation in the mining sector where government owns a 51% stake in the company. As shown in Table 1, the organisations are of different sizes, for example, in 2018, OrgA and OrgB had 120 and 3,200 employees, respectively. Furthermore, between 2016 and 2018, OrgA and OrgB implemented 11 and 32 projects,

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respectively. Most of the implemented projects by OrgA had a tourism connection and were developed in partnership with local communities, requiring extensive external stakeholder management. The projects involved construction of accommodation facilities, provision of leisure facilities and cultural and historical preservations. On the other hand, the projects that OrgB implemented were non-mining in nature (the focus of the study) and included mining support functions, welfare projects, security and IT related projects. The projects were of various durations, for example, maximum duration for projects for OrgA and OrgB was 18 and 24 months, respectively. Lastly, the development expenditures and the maximum project budget values also differed.

Table 1: Profile of Projects implemented by the two organisations

Attribute	OrgA	OrgB
Employees (no.)	120	3,200
Projects implemented between 2016-2018 (No.)	11	32
Maximum project Duration (months)	18	24
Development Expenditure (BWP'billion*)	2.0	300.0
Project value (BWP'million)	14.9	200.5

*1€=12.5 BWP

3.2. Data Collection and Analysis

In order to obtain an in-depth understanding of the effectiveness and practices used in managing lessons learned four data collecting methods were used to obtain triangulated findings. These included document review, questionnaire, interviews and focus group discussions. Documents reviewed included end-of-activity reports, project evaluations, terms of reference, progress reports, meeting minutes and in one case a project audit report. The documents were reviewed throughout the data collection period to understand and affirm some of the practices used in managing lessons learned. Second, a questionnaire, with both closed and open-ended-questions, was administered to a purposively selected sample of participants based on their involvement in the identified projects in the two organisations. Respondents included project portfolio managers (PPM), project managers (PM) and project team members (PTM) as shown in Table 2. The questionnaire sought to obtain views of the respondents on the organisation approaches to lessons learned and a self-assessment of the effectiveness of a particular process. It consisted of three sections with the first requesting respondents' profiles and projects worked on while the other two sections probed the effectiveness of the lessons learned process and the environment in which the process was managed. The level of effectiveness and severity of barriers to managing lessons learned was measured by the rubrics indicated in Table 3 from which mean values were computed. Judging from the period majority of participants worked (five years and above) in the organisations, it was felt that they could have substantial insights of how lessons learned are managed in the two organisations. Third and as a follow-up to the questionnaire, two focus group discussions

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were held, consisting of eight members from the project teams of the two organisations. Each focus group discussion lasted an hour. Fourth, two interviews were conducted with the respective PPMs in the two organisations to seek clarity on certain aspects and hence obtain a management of the process. Each interview lasted between thirty to forty minutes. The interviews and focus group discussions were guided by a protocol which was constructed from an analysis of the results obtained from the questionnaire.

Table 2: Profile of Respondents

Attribute		No. of PPM	No. of PM	No. of PTM	Total
Responsibility	OrgA	1	6	15	21
	OrgB	1	11	40	51
Duration in organisation (years)		less than 10	10-19	20 and over	
	OrgA	11	8	2	21
	OrgB	23	18	10	51

Table 3: Scales for measuring the effectiveness and barriers to managing lessons learned

Effectiveness	Rank Score	Average Range	Severity of Barrier
Not effective	0	<0.5	Does not affect
Minimally- effective	1	0.5-1.4	Rarely Affects
Moderately effective	2	1.5-2.4	Moderately affects
Effective	3	2.5-3.4	Highly affects
Highly effective	4	>=3.5	Always Affects

4. Results and Findings

A perusal through documents of the two organisations indicated that a number of projects had experienced cost and time overruns, in addition to quality issues. Discussions with the project teams indicated that some of the causes of the time and cost overruns often recurred during project implementation confirming the need for the study and a motivation for further investigation.

4.1. Level of Effectiveness of Lessons Learned Process

Figure 2 provides a summary of results of the effectiveness of the sub-processes relating to the management of lessons learned. Though the effectiveness of managing lessons learned in the two organisations is at different levels of maturity, none of them may be described as highly effective (4 out of 4 based on the scale in Table 3). The lessons learned process in OrgB is moderately effective (overall score of 2.4 out of 4) as opposed to that of OrgA (score of 1.4 out 4) which is minimally effective. In both cases the most developed process is that of storage which is effective (2.6 out 4) in OrgB and moderately effective (2.0 out of 4) in OrgA. During interviews and focus discussions of project members from both organisations attributed their assessment to a reliable intranet system which contains manuals,

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policies, procedures, guidelines, checklists and relevant templates. They noted that to them these aspects were developed fully following lessons learned from past project experience. However, they conceded that their development did not follow a formal path in the sense of a lessons learned process as indicated in section 2.2 was often based on recollections from experienced project team members.

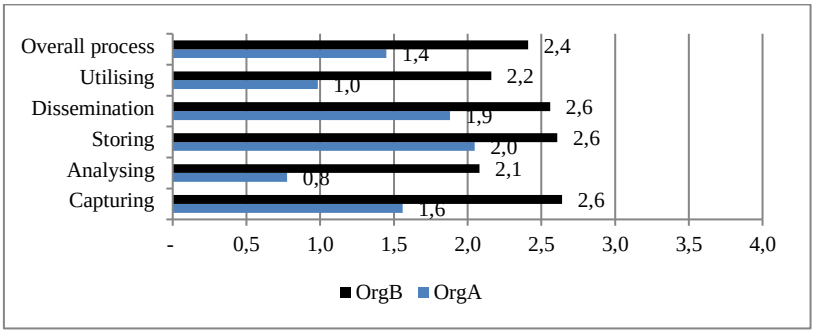

Figure 2: Level of effective management of lessons learned processes

4.2. Level of formality in managing lessons learned

Given the observation that there were formal and informal ways of capturing lessons learned in the two organisations, respondents were requested to estimate the extent to which both systems were practiced. Figure 3 indicates the respondents' overall estimate of the use of informal methods of managing lessons learned in both organisations i.e. 68.2% in OrgA and 61.5% in OrgB. This result corroborates the low effectiveness shown in the results in Figure 2.

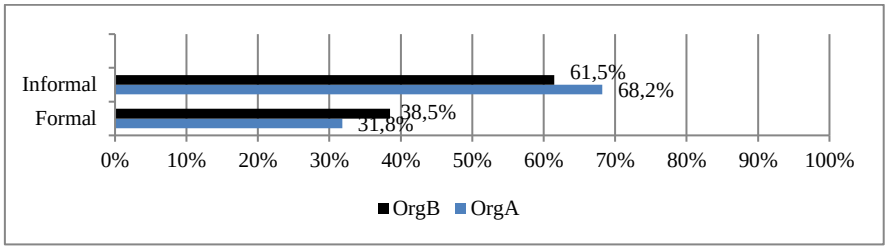

Figure 3: Level of usage of informal processes in managing lessons learned in the two organisations

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4.3. Level of use of lessons learned in project management processes

Participants were also requested to indicate the level of effectiveness in using lessons learned in key project management processes which were construed out of some of the 'ten project knowledge areas' prescribed by Project Management Institute (PMI) [11]. Figure 4 indicates the results of the probe and the result is similar to the one before in that OrgB derives better value in lessons learned than OrgA in enhancing the knowledge areas as indicated at the top of Figure 4 (overall enhancement score of the processes of 2.5 and 1.5 by OrgB and OrgA, respectively). However, there was a feeling that some processes get the benefit of using lessons learned more than others, for example stakeholder (3.2), procurement (3.2) and cost (3.1) management. However, this did not contradict in any way that this could be achieved by means of an informal process as one PPM '*issues of procurement, cost and duration of a project are often remembered as they have a knock off effect on stakeholders'.*

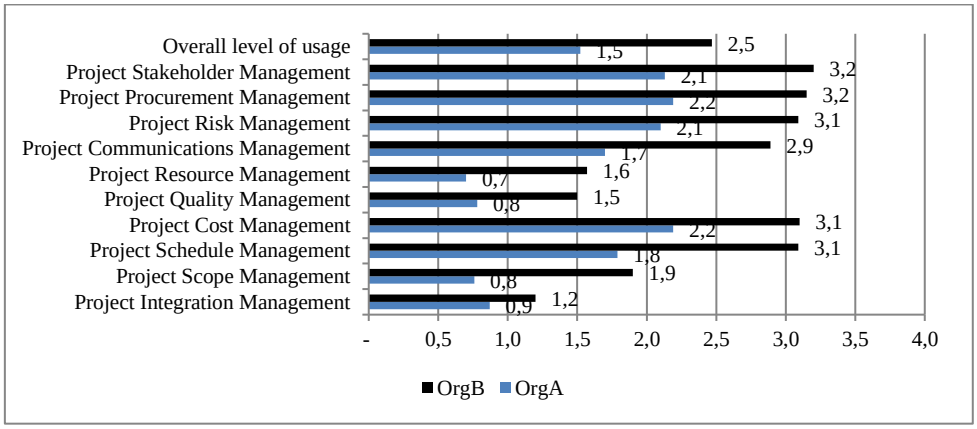

Figure 4: Effective usage of lessons learned in the project management knowledge areas

4.4. Barriers to Effective Development of Lessons Learned Process

The two project teams from both organisations were requested to indicate barriers which they perceive to affect the effective management and especially the utilisation of lessons learned during implementation of projects. As the two rating lines in Figure 5 indicate, there was commonality by participants from both organisations about the most frequent barriers.

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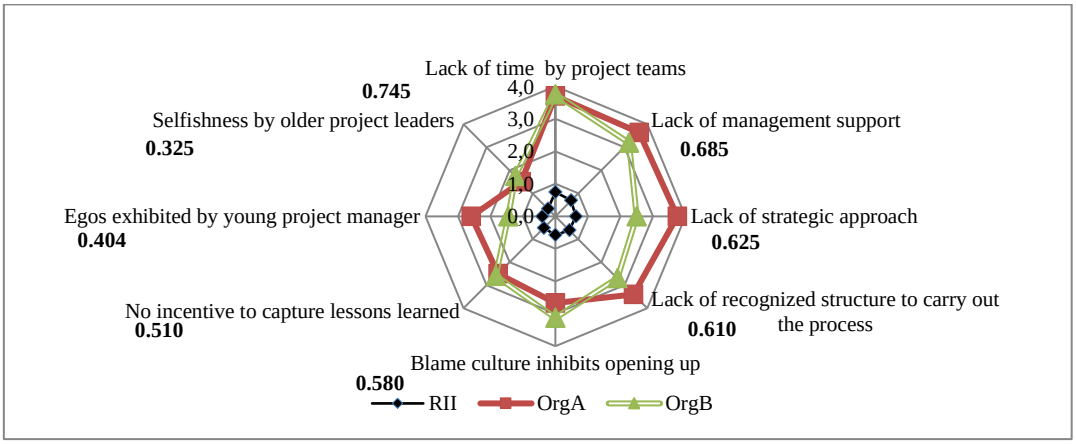

Figure 5: Perceived barriers to the effective management of lessons

For easy analysis, a composite relative importance index (CRII) was constructed from the ratings of each barrier by participants from OrgA and OrgB (line in middle of Figure 5 with indices shown by the labels). Two groups of factors were identified as significant barriers. First group relates to project teams namely *lack of time by project teams to manage the process on its own* (RII=0.745). Second group relates to lack of institutionalisation of the lessons learned process - *lack of support by management; lack of management support* (RII=0.685); *lack of strategic approach* (RII=0.633); and *lack of recognised structure to carry out the process* (RII=0.610). Essentially, in both organisations management has not formulated a policy towards managing lessons learned and provided the motivation to sustain the culture of using lessons learned and hence the utilisation is minimal as already noted.

5. Conclusion

The study set out to investigate the extent to which lessons learned process is managed in organizations in two selected organisations. Literature sources provide the major tasks required to manage an effective lessons learned process that include capturing, validating, archiving, retrieving, disseminating and utilizing. For effective achievement of these tasks requires using efficient tools and best practices which leverage on contemporary technology. A multiple-methods approach was used for the study that involved document review, questionnaire, focus group discussions and interviews with key people overseeing project implementation from each organisation.

The findings indicated that majority (68.2% and 61.5% for OrgA and OrgB, respectively) of lessons learned and used in project implementation are derived from an informal processes involving

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recollection of experiences by project teams. As a consequence, the lessons learned process is minimally developed (1.4 out of 4) and moderately developed (2.4 out of 4) in OrgA and OrgB, respectively. Similarly, the knowledge areas as espoused by the PMI [11] are not enhanced by the formal method of lessons learned process in the two organisations. Essentially it can be concluded that in the two organisations studied, the lessons learned process is not effectively managed. Barriers to effective management of lessons learned emanate from lack of institutionalisation of the process where its value is not articulated by management and hence project teams not well supported to manage the process.

In conclusion, though the study had an inherent limitation of studying two organisations, results have provided an insight to extent to which lessons learned are used in implementing projects. Improving utilisation of lessons learned requires formulating strategies for overcoming the identified barriers and developing a culture of effectively managing them Extending the investigation to more organisations with a view to formulating possible solutions to overcome the inherent barriers is highly recommended.

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The Risk Management Question and the Project Manager/Engineer in Practice Under FIDIC Contracts – the Conundrum of Project Participants Behaviours

Rwelamila, P.D[a]. and Ssegawa, J.K[b]*

[a]*Graduate School of Business Leadership (GSBL), University of South Africa (UNISA), P O Box 392, UNISA 0001, Pretoria. South Africa.*
[b]*Department of Civil Engineering, Faculty of Engineering and Technology, University of Botswana, P. Bag 0061, Gaborone*

Abstract

Most construction projects operate in an environment composed of uncertainty. There is uncertainty regarding construction project funding, the availability of necessary resources, potential technical problems – the list seemingly endless. In construction project management practice, risk is a function of the uniqueness of a construction project and the experience of the construction project team. The Project manager/Engineer (PM/Engineer) and the project team should accept that risk level in a construction project is associated with the certainty that outcomes will be as expected. Thus, high certainty outcomes have low risk; low-certainty outcomes have high risk. Certainty derives from knowledge and experience gained in prior projects as well as the PM/Engineer's ability to mitigate anticipated risks and respond to project emerging problems. Since the notion of construction project risk involves the likelihood that some problematic even will occur, and the impact of the risk event if does occur, a project contract – FIDIC in this case should help the PM/Engineer to reduce such impacts. This paper is based on the foundation argument that proper risk allocations in construction projects contracts can help reduce such impacts and achieve management efficiency. Reflecting on four categories of risk: natural; political and social; economic and legal; and behaviours risk, it is argued that universally accepted generic risk management processes are used. The application of those processes requires integration of risk management with PM/Engineer processes and activities. While generic risk management processes are adequate for risk events falling under the first three categories, the fourth category of risks – behaviours risks, require more innovative approaches,

* Corresponding author. Tel.: +27823783512; Fax: + 27 11 652 0299
E-mail address: RwelamilaP@ub.ac.bw; Rwelapmd@unisa.ac.za

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especially during the last three steps of project risk management - treating risks, monitoring and reviewing of risks and communicating and consulting. The paper emphasizes on the innovative ways available to the PM/Engineer to manage behaviours risks.

Keywords: Behahivoural risks, FDIC, risk management, construction, engineer, project manager.

1. Introduction

A closer analysis of various literature sources from risk management scholars and practitioners would suggest that there have been great efforts in generalizing the risk allocation principles that facilitate producing the best possible project outcome. They (e.g. Abrahamson, 1973; Ashley, 1977; Barnes, 1983; Ward, Chapman and Curtis, 1991;Cheung 1997; Hillson & Simon; 2012; Jordan; 2013) have discussed the general principles on risk allocation in construction and other types of projects. The five theoretical principles proposed by Abrahamson (1973) and supported by Hillson & Simon (2012) provide guidance on how risk shall be allocated to the key parties on a construction project namely if: (i) the risk is of loss due to his own willful misconduct or lack of reasonable efficiency or care; (ii) he can cover the risk by insurance and allow for the premium in settling his charges, and it is most convenient and practicable for the risk to be dealt with in this way; (iii) the preponderant economic benefit of running the risk accrues to him; (iv) it is in the interests of efficiency to place in the risk on him; and (v) when the risk eventuates, the loss happens to all on him in the first instance, and there is no reason under any of the above headings to transfer the loss to another, or it is impracticable to do so.

Typical construction project risk management approaches put emphasis on the objective of project risk management as to identify and manage significant risks. This involves several key phases, with feedback through a monitoring and review process. This paper provides a brief summary of construction project categories of risks and their respective generic risk management processes. It further provides a reflection on the categories of risks in the context of a project manager or engineer (PM/Engineer) navigating through various project risk events in practice. Closer lenses are direct at behaviours risks, which various PM/Engineer practitioners have found more challenging during the later stages of the risk management process.

2. Categories of Risks

For the purpose of risk management processes, researchers have developed various risk categorization framework. Zhi (1995) classifies construction risks into four levels: nation/region; construction industry, company and project levels. Under these four levels, a subdivision is made, such

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as political, economic, market, physical risks, etc. Edwards and Bowen (1999) identify risk first into two basic categories: natural and human. The natural risks are subdivided into weather and geological risks; the human risk is subdivided into 9 types, such as social, political, economic, legal, cultural, etc. Han and Diekmann (2001) list five categories of risk: political, economic, cultural legal, technical/construction and other risks, which are further subdivided. Based on this categorization and for the ease of comparison, a categorization framework was developed by Zhang, Zhang and, Gao (2006) illustrated in Figure 1 is adopted.

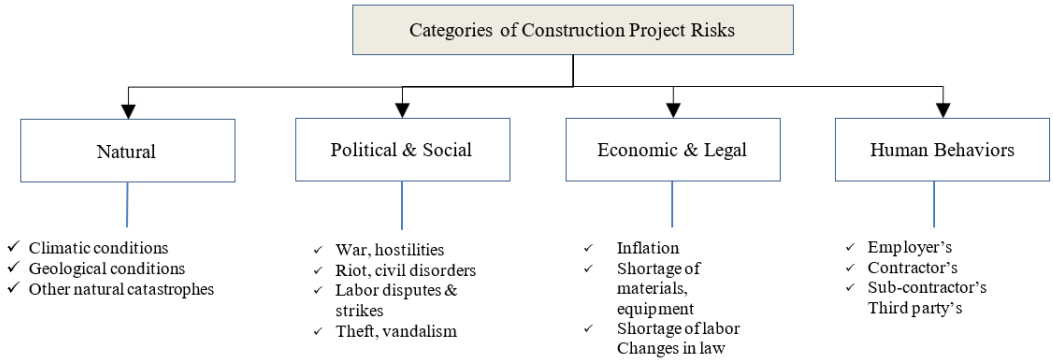

Figure 1: Categories of Risk

3. The Risk Management Process

According to Thomas (2020), the risk management process is a framework for process and actions that need to be taken also known as the *risk management process* illustrated in Figure 2. The process has five steps beginning with identifying risks; analyzing risks; prioritizing; implementing a solution; and finally risk tracking. Each step in practice involves a lot of documentation and administration at construction project environment level. Due to the required brevity, only an overview of the process is provided (details on risk management process various sources are available e.g. Hillson & Simon 2012; Jordan, 2013; and Coper, Grey, Raymond and Walker 2005).

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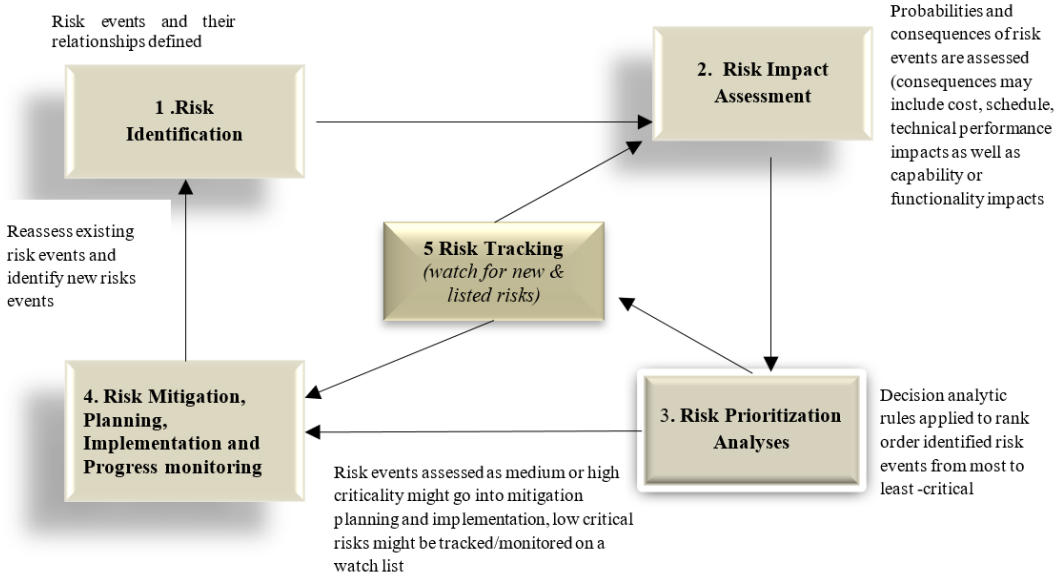

Figure 2-Fundamental steps of risk management, (Source: adapted from Garvey, 2015)

3.1. Identify the risk

The first step for the construction PM/Engineer is to identify the risks that the project is exposed to in its operating environment. There are many different types of risks as categorized under Figure 1. It is important to identify as many of these project risk factors/events as possible. In a manual environment, these risks are noted down manually otherwise if the project has a risk management solution employed all this information is inserted directly into the project management information system. The advantage of this approach is that these risks become visible to every project stakeholder with access to the system. Instead of this vital information being locked away in a report which has to be requested via email, anyone who wants to see which project risks have been identified can access the information in the project risk management system.

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3.2. Analyze the Risk

Once a project risk event has been identified it needs to be analyzed. The scope of the risk must be determined. It is also important to understand the link between the risk and different factors within the project. To determine the severity and seriousness of the risk it is necessary to see to what extent the project will be affected by the risk. There are risks that can bring the whole project to a standstill if actualized, while there are risks that will cause minor inconveniences. In a manual risk management environment, this analysis must be done manually. When a risk management solution is implemented one of the most important basic steps is to map risks to different project documents, policies, procedures, and project processes. This means that the system will already have a mapped risk framework that will evaluate risks and let the PM/Engineer know the far-reaching effects of each risk.

3.3. Evaluate or rank the risk

Project risks need to be ranked and prioritized. Here the PM/Engineer uses the risk severity matrix (Coper, Grey, Raymond and Walker 2005) to provide a basis for prioritizing which risks, to address. Red zone risks receive first priority followed by yellow zone risks. Green zone risks are typically considered inconsequential and ignored unless their status changes. Most construction project risk management solutions have different categories of risks, depending on the severity of the risk. A risk that may cause some inconvenience is rated low while risks that can result in catastrophic loss are rated the highest. It is important to rank risks because it allows the PM/Engineer to gain a holistic view of the risk exposure of the whole organization. The project may be vulnerable to several low-level risks, but it may not require upper management intervention. On the other hand, just one of the highest-rated risks is enough to require immediate intervention.

3.4. Treat the risk

Every project risk needs to be eliminated or contained as much as possible. As a follow-up from Stage 3 prioritization of risks, the PM/Engineer must make a decision concerning which response is appropriate for the specific risk event. Treating the risk or response to risk can be classified as mitigating, avoiding, transferring, sharing, or retaining. Deciding on these options. This is done by connecting with the experts of the field to which the risk belongs. In a manual environment, this entails contacting each and every project stakeholder and then setting up meetings so everyone can talk and discuss the issues. The problem is that the discussion is broken into many different email threads, across different documents and spreadsheets, and many different phone calls. In a project risk management solution, all the relevant project stakeholders can be sent notifications from within the project system set-up. The discussion regarding the risk and its possible solution can take place from within the project

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system. The PM/Engineer should always keep a close eye on the solutions being suggested and the progress being made within the project system. Instead of everyone contacting each other to get updates, everyone can get updates directly from within the project risk management solution.

3.5. Risk tracking/Monitoring and reviewing the risk

Not all project risks can be eliminated – some risks are always present. Under project manual systems monitoring happens through diligent internal project stakeholders. The PM/Engineer and project team members should make sure that they keep a close watch on all risk factors. Under a digital environment, the project risk management system monitors the entire risk framework of the project. If any factor or risk changes, it is immediately visible to the PM/Engineer and the project team. Computers are also much better at continuously monitoring risks than people. Monitoring risks also allows the project to have a project management reliable system and thus ensuring continuity.

It is worth noting that the above are generic risk management steps including the construction project environment. What changes is how efficiently these steps can be taken, and as it should be clear by now, there is simply no competition between a manual risk management system and a digital one. There are also many new risks that projects may be facing for the first time, and modern project challenges require modern solutions.

4. Behavioral Risks

Construction project participants include the client, contractors, material suppliers, the client representative (PM/Engineer) (Xiang, Jia and Li 2018). Project participants' behavior will have a significant impact on project performance (Xiang, Ren, Zhong and Feng 2007). While each participant has their own particular interests, each individual participant is driven by achieving maximum benefit, which can result in improper behavior towards each other, yet this may negatively affect the success of the project. Barnes (2002) points out that human risk factors in project management should be taken seriously, and behavioral factors in project management play an increasingly important role (Barnes 2002). For human risk factors, Xiang, Jia and Li (2018) argue that some of these are due to the objective conditions or capability of participants caused by information asymmetry, such as "contractor's poor technical capability, management or even understanding of the contract"; for the rest of them, due to inconsistency with regard to the target of maximizing benefit between the owner (the principal – through himself/or herself or PM/Engineer as representative) and the contractor (as the agent), in order to achieve maximum benefit, the agents would be willing to take action. That is not of benefit to the principal, leading to loss of profits by virtue of their proprietary information advantage, such as "client changes project objection or invest direction", "designer uses technological capabilities advantage to obtain profit", and so on. The risk of moral hazard and adverse selection based on information

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asymmetry can be considered behavioral risks for principal participants (Xiang, Zhou, Zhou and Ye (2012). Therefore, human risk can be divided into non-malicious factors and malicious factors.

Non-malicious factors are mainly caused by non-subjective intention of participants, meaning that the risks result from limitations in terms of capability, resources or hardware of humans, rather than malicious intent. Malicious factors are caused by improper actions taken by participants in order to maximize their own interests. The behavioral risk of principal participants in this article is defined as malicious action taken by project participants (Xiang and Kong 2010). Behavioral risk of principal participants is a component of basic risk and exists in the behavior of the project participants; and the risk results directly affect the whole project subject group. Therefore, reducing the behavioral risk factors of the principal participants is a prerequisite to achieving a "win-win" or "multi-win" situation by the PM/Engineer (Yang 2003). Although there is a lot of research on human risk in construction projects, non-malicious and malicious factors are often considered synthetically, or only a certain kind of malicious factor is addressed. There is no systematic identification and analysis of malicious factors, making it unable to provide effective guidance for construction project management practice. Table 1 summarizes the identification of Employer's behavioral risks (including the PM/Engineer) in construction projects based on FIDIC Contract clauses.

Table 1: Employer's behavioral risks

Risk Event	Relevant Clause (FIDIC)
i) Late giving possession of site	2.1
ii) Non notification of financial arrangements upon request	2.4
iii) Delay in payment	14.8 & 16.2
iv) Unreasonably withholding permissions or certificates	1.3
v) Defects in design drawings	17.3
vi) Occupation of the Works	17.3
vii) Notifying incorrect setting-out data	4.7
viii) Late issuance of design drawings or instructions	1.9
ix) Late attendance to tests or inspections	9.2
x) Interference with tests on completion	10.3

Source: FIDIC (2010); FIDIC (2000); Totterdill (2008)

Table 2 summarizes the identification of Contractor's and third party behavioral risks in construction projects based on FIDIC Contract clauses. Here, depending on the project procurement system, the contractor could include the main contractor and nominated sub-contractors (or specialist contractors). Third parties could include local authorities and utility organisations (e.g., authorities responsible for power supply, water, etc.).

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Table 2: Contractor's & third party behavioral risk

Party	Risk Event	Relevant Clause (FIDIC)
a) Contractor's behavioral risks:	i) Labor injuries & accidents	4.1
	ii) Improper interference with convenience of the public	4.14
	iii) Damage caused by transportation of goods	4.16
	iv) Acts or defaults by subcontractors	4.4
	v) Defects in materials, plant & workmanship	7.1 & 7.5
b) Third party behavioral risks:	i) Unauthorized entry	4.22
	ii) Delay caused by authorities	8.5

Source: FIDIC (2010); FIDIC (2000); Totterdill (2008)

A closer reflection of possible risk behaviors by construction project participants in Tables 1 and 2 will demand great effort from the PM/Engineer to mitigate them through change management initiatives. Change from these behaviors cannot be forced upon construction project participants, but these behaviors can be shaped and guided by the PM/Engineer, especially those behaviors by the employer based on the power structure between the employer and the PM/Engineer (the need to remain impartial as FIDIC contract demands).

From conception of the project the PM/Engineer should base his/her management efforts on the foundation belief that project behaviors and cultures can be shaped and guided through:

i) *Guide, do not mandate:* Project participants cultural and behavioral changes require a movement, not a mandate. This means delving deeply into the project objectives, project team beliefs, and values of an employer's culture – then adjusting those to reflect an appropriate culture.
ii) *Lead does not dictate:* True PMs Lead by example. They embody change first, demonstrating the behaviors and attitudes that they are seeking to achieve. This approach will go a long way towards earning trust and support from project participants.
iii) *Explain the why as well as the what:* Explaining the reasons for an activity or change will drastically improve results. By helping project participants (including the employer) understand the "why" of change management, project participants will understand the purpose of a proposed change – then they will have a reason to support that change.

According to Heath and Heath (2011) successful changes share a common pattern. They require the leader (here the PM/ Engineer as the leader of the change of behaviors) to do three things at once. To change any project participant's behavior, by changing the participant's situation. For individual project participant's behavior to change, the PM/Engineer has to influence not only their project environment but their hearts and minds. Thus, Heath and Heath (2011) noted:

i) *Direct the Rider:* What looks like resistance to change behavior is often a lack of clarity. So, the Engineer/PM should provide crystal-clear direction.

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ii) *Motivate the Elephant:* What looks like laziness is often exhaustion. The Rider can't get his or her way by force for very long. So, it is critical that the PM/Engineer engage project participant's emotional side – get their Elephants on the path and cooperative (teamwork).
iii) *Shape the Path:* What looks like a project participants problem is often a situation problem. The situation (including the project surrounding environment) is called the Path. Hence when the PM/Engineer shapes the Path, he or she makes change more likely, no matter what's happening with the Rider and Elephant.

From the foregoing, Heath and Heath (2011) provide a clear framework to the Engineer/PM to change behaviors (Table 1 and 2). The PM/Engineer has to *direct the Rider, motivate the Elephant, and shape the Path*. They strongly argue that, if the Engineer/PM can do all three at once, dramatic change can happen.

Heath and Heath (2011) innovative approaches for a PM/Engineer to militate against project participant's behavioral risks (Table 1 and 2), described above are supported by Coyle's (2018) work on *'group culture'* inside successful businesses. He advocates for what he calls a specific set of skills for a PM/Engineer. These skills include: *Skill 1* – the need for a PM/Engineer to *Build Safety* **–** where signals of connection will generate bonds of belonging and identity between project participants; *Skill 2* – the need to *Share Vulnerability* – where habits of mutual risk among project participants will drive trusting cooperation; and *Skill 3* – the need to *Establish Purpose* – where narrative cooperation between project participants create shared goals and values. In summary, the PM/Engineer's innovative approaches to manage behavioral risks should embrace three things as illustrated in Table 3.

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Table 3: The PM/Engineer Acting differently to manage behavioural risks

Role of PM/Engineer	Action
a) The PM/Engineer to Direct the Rider	i) *Follow the bright spots* – investigate what's working and clone it – solutions-focused therapy. ii) *Script the Critical Moves* – don't think big picture, think in terms of specific behaviors. iii) *Point to the Destination* – change is easier when you know where you are going and why it is worth it.
b) PM/Engineer to Motivate the Elephant	i) *Find the Feeling* – knowing something is not enough tom cause change. Make project participants feel something. ii) *Shrink the Change* – break down the change until it no longer spooks the Elephant – project management approach reform. iii) *Grow your People* – cultivate a sense of identity and instill the growth mind set for all project participants.
c) PM/Engineer to Shape the Path	i) *Tweak the Environment* – when the situation changes, the participant's behaviors change. So, change the situation. ii) *Build Habits* – when behavior is habitual, it is free – it doesn't tax the Rider. Look for ways to encourage habits. iii) *Rally the Herd* – behavior is contagious. Help it spread.

5. 5 Conclusion and Recommendation

Construction project failures are partly influenced and determined by many behavioural factors by the principal participants. It is practical and necessary to identify and understand all the behavioural risks in order to minimize their influence on construction project. It is a smarter way to find ways of managing project participants risk behaviours in order to reduce the risk of project failure.

In this paper, we have reflected on possible behavioural risks as described in various FIDIC contract clauses with the potential to affect successful completion of projects as a result of principal participants' behaviour. Harvesting contemporary approaches on 'How to change things' (Switch) by Heath and Heath (2011) and 'The culture code' by Coyle (2018), specific strategies that encourage collaboration and building trust have been briefly described. While the 'The culture code' provides a skill set of approaches that will change the way project participants think and work together, 'Switch' compliments 'The culture code' by mining the latest psychological research to work out how to engage project participants emotional brain, and encourage them to focus on 'bright spots' – techniques proven to help project participants change bad habits or behaviours. These innovative approaches for the PM/Engineer in managing behavioural risks enrich the theoretical research on risk management of construction projects, providing additional guidance for project managers with regard to risk management, not only

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identifying key points of risk management in construction projects for principal participants, but also serving as a useful reference for further studies on methods to manage these risks. It is important to note that this paper provides few contemporary building blocks in managing project participant's behavioural risks. Further studies will need to explore how to strengthen the approaches in managing project participants behavioural risks described in this paper.

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A computational infrastructure for semantic data integration towards a patient-centered database for Tuberculosis care

Vinícius Costa Lima[a,b], Filipe Andrade Bernardi[a,b], Michael Domingues[c], Afrânio Lineu Kritski[d], Rui Pedro Chaters Lopes Rijo[e], Domingos Alves[f]

[a] *Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil*
[b] *Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil*
[c] *Faculty of Engineering, University of Porto, Porto, Portugal*
[d] *Medical School, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil*
[e] *School of Technology and Management, Polytechnic Institute of Leiria, Leiria, Portugal*
[f] *Department of Social Medicine, Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil*

Abstract

Tuberculosis is an infectious disease that is among the top 10 causes of death in the world and Brazil ranks in the top 30 high TB burden countries. In this scenario, data integration and sharing are crucial to the construction of efficient and effective evidence-based decision-making tools and to enable data-driven research. Through a socio-technical approach, this work proposes a computational infrastructure composed of a functional and semantic interoperability layer and security mechanisms to integrate national level health information systems towards a patient-centered unified database to provide a broad view of a patient across several isolated databases. The CMIID, a medical information identifier for data harmonization, developed by the University of Porto, was used for the linkage of patients across these health information systems and to perform records anonymization for privacy of personal health information. Through the integration of such systems, it is possible to gather, summarize and visualize TB data in a single system, which can be useful for health professionals and managers. Therefore, this work sought to promote the integration of disparate systems and the availability of data to support decision-making and research, which are fundamental for improving the quality of TB services in Brazil.

Keywords: tuberculosis; interoperability; semantic web; health information systems; decision support; data integration.

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A Micro-analysis Approach in Understanding Electronic Medical Record Usage in Rural Communities: Comparison of Frequency of Use on Performance Before and During the COVID-19 Pandemic

Paulyn Jean Acacio-Claro[a,b], Maria Regina Justina Estuar[c], Dennis Andrew Villamor[c], Maria Cristina Bautista[a], Quirino Sugon Jr.[d,e], Christian Pulmano[c]

[a]*Graduate School of Business, Ateneo de Manila University, Philippines*
[b]*Unit of Health Sciences, Faculty of Social Sciences, Tampere University, Finland*
[c]*Department of Information Systems and Computer Science, School of Science and Engineering, Ateneo de Manila University, Philippines*
[d]*Solid Earth Dynamics / Upper Atmosphere Dynamics Laboratory, Manila Observatory, Philippines*
[e]*Department of Physics, School of Science and Engineering, Ateneo de Manila University, Philippines*

Abstract

In strengthening eHealth in the Philippines to support the universal health care (UHC) law, the scaling up and full adoption of electronic medical record (EMR) systems was strategically scheduled and supposedly completed in 2020. The Covid-19 pandemic, however, delayed these strengthening efforts. We wanted to assess the status of EMR adoption in primary clinics of rural health units (RHUs) and understand the frequency of use, particularly during the pandemic. Through analyses of EMR usage logs from selected RHUs in 2020, we estimated frequency of EMR usage based on duration of use and tested if this was influenced by the performing RHU and pandemic event. We also determined the most frequent EMR activities through process maps and tested if there were differences in the conduct of these activities before and during the pandemic. Results showed that EMR use during work hours was significantly dependent on the performing RHU ($p<0.001$). High-performing RHUs used EMRs more than 3 hours/day while low-performing RHUs used the systems for less. The pandemic either significantly decreased or increased EMR use during work hours by around 5 hours/day in some RHUs ($p<0.01$). Process maps revealed that there were additional activities performed by RHUs during the pandemic. Except for Update Patient Profile and Add Patient EMR features, significant differences ($p<0.01$) were observed in accessing frequently used features before and during the pandemic. The results suggest some uneven level of utilization of EMRs at the primary care level which can impact readiness to support full implementation of the UHC law. The study shows

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the potential of using a more granular approach in studying adoption to help improve the quality of EMR use and contribute to improving health service delivery and financing.

Keywords: EMR usage; process mining; pandemic; usage logs; rural health units.

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A Scoping Review of Digital Solutions that Might be Used as Cognitive Screening Instruments of Community-Dwelling Older Adults

Rute Bastardo[a], João Pavão[b], Ana Isabel Martins[c], Anabela G. Silva[c], Nelson Pacheco Rocha[d]

[a]*UNIDCOM, Science and Technology School, University of Trás-os-Montes and Alto Douro, Quinta de Prado, 5001-801 Vila Real, Portugal*
[b]*INESC-TEC, Science and Technology School, University of Trás-os-Montes and Alto Douro, Quinta de Prado, 5001-801 Vila Real, Portugal*
[c]*CINTESIS.UA , Health Sciences School, University of Aveiro, Aveiro 3810-193, Portugal*
[d]*IEETA, Department of Medical Sciences, University of Aveiro, Aveiro 3810-193, Portugal*

Abstract

Cognitive health status is a determining factor for quality of life. Since early identification of mild cognitive impairment is critical to better manage further decline, and to guide therapeutic and rehabilitation interventions, there is the need for efficient clinical instruments able to monitor the individuals, particularly older adults, in their residential environments. This paper presents a scoping review to identify of innovative digital solutions to detect cognitive impairments and that might be used as a screening tool for age related cognitive impairment of community-dwelling older adults. Nineteen articles were included in this scoping review. As a main conclusion, most of the included articles report digital solutions to support the application of existing paper-based clinical instruments to assess specific or multiple cognitive functions. However, six studies explore new approaches to assess cognitive functions including virtual reality and serious games.

Keywords: Older adults; Cognitive screening; Cognitive tests; Digital solutions.

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A timeline model for clinical events: empowering data

Rute Bastardo[ab*], Mariana Castro[b], João Pavão[ac], Luis Ramos[d]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real, Portugal*
[b]*UNIDCOM/IADE-Unidade de Investigação em Design e Comunicação, Lisbon, Portugal*
[c]*INESCTEC, Porto, Portugal*
[d]*Centro de Salud Zona Centro, Badajoz, Spain*

Abstract

Data visualization is key in the Big Data context, enabling different cognitive perspectives over large datasets. These visual perspectives can prompt relevant advantages with regard to healthcare records, because they may contribute to a faster, more understandable, and adequate way to capture patients' health history and overall condition, thus improving healthcare quality.
Timelines are well-known visual artifacts that help healthcare professionals to visualize patients' electronic health records (EHR) over a time period. As data stored in EHR tend to quickly grow with each interaction between patient and healthcare system both number and size, traditional linear timelines are can increasingly become more difficult to manage visually, as they often span over different screens. Considering that a holistic analysis is desirable to provide proper and quality health services, data visualization should enable a seamless understanding of patients' health history and overall condition. When dealing with critical episodes - such as an emergency - where time is an important factor, this is even more decisive. Furthermore, traditional timelines do not support multidimensional data representation. This paper presents a new visual model of time-dependent EHR based on radial models. It is capable of simultaneously displaying several data categories that characterize patients' medical history, enabling medical professionals to be aware of different data categories over time in a single display, without the need to scroll between screens.

Keywords: Data visualization; timeline; Eletronic Health Records.

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Abnormality classification in small datasets of capsule endoscopy images

Filipe Fonseca[a,b], Beatriz Nunes[a], Marta Salgado[c], António Cunha[a,b]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real Vila Real 5000-801, Portugal*
[b]*INESC TEC, Porto 4200-465, Portugal*
[c]*Centro Hospitalar Universitário do Porto, Porto 4099-001, Portugal*

Abstract

Capsule endoscopy made it possible to observe the inner lumen of the small bowel, but with the cost of a longer duration to process its resulting videos. Therefore, the scientific community has developed several machine learning strategies to help in detecting abnormalities in these videos. The published algorithms are typically trained and evaluated on small sets of images, ultimately not proving to be efficient when applied to full videos. In this experiment, we explored the problem of abnormality classification within an unbalanced dataset of images extracted from video capsule endoscopies, based on a vector feature extracted from the deepest layer of pre-trained Convolution Neural Networks to evaluate the impact of transfer learning with a small number of samples. The results showed that there is a reliable model on the classification task using small portions of data from video capsule endoscopies.

Keywords: Image classification; capsule endoscopy; medical imaging; deep learning; transfer learning.

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Audiovisual translation models for visually impaired users of Interactive Television (iTV)

Rita Oliveira, Jorge Ferraz de Abreu, Ana Margarida Almeida

DigiMedia, Department of Communication and Arts, University of Aveiro, 3810-193 Aveiro, Portugal

Abstract

Audiovisual translation techniques, such as audio description (AD), subtitling and dubbing, have a significant role in the overall television experience of people with visual or hearing impairments, illiterate or persons unfamiliar with foreign languages. These techniques are assured by qualified professionals using specific technical resources, resulting in expensive production processes. However, new models to support alternative and more affordable audiovisual translation techniques can be used in the current interactive television (iTV) ecosystem.
This paper aims to discuss two models to produce audiovisual translation (voluntary audio description and automatic reading of subtitles), which present the potential to increase the offer of TV contents adapted to the aforementioned persons.
An integrative literature review was carried out in order to identify and define the technical framework inherent to the proposed models. The main findings of the performed analysis show that the models have technical viability enabling its technical implementation.

Keywords: audiovisual translation; accessibility; audio description; subtitling; interactive television.

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Care by video consultations: why or why not?

Jan Aidemarka

[a] *Linnaeus University, 351 95, Växjö, Sweden*

Abstract

The practice of using video conferencing systems for health care provider-patient meetings is becoming increasingly more important. Here, we reviewed literature on the subject, with the aim to provide a set of factors and perspective on what has been noted as important for the success/failure of the use of video in consultation meetings. Mostly, previous studies have focused on the outcomes, how well video works for the patient-care professional meeting, when it comes to affecting expected outcomes of the consultation. However, we focus on the contextual factors that have been noted in research on the topic and aim to gather these from a wide range of studies on video used in a home environment. We discuss the results of the study in the broader context of the implementation situation of video consultations systems, providing factors, barriers, and perspectives as well as a general context to use or non-use of the systems. Hence, we provide knowledge that can be taken into account by the designers and developers of such systems.

Keywords: Telehealth; Video consultation; ehealth; literature review.

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Clinical Interactions in Electronic Medical Records Towards the Development of a Token-Economy Model

Nicole Allison S. Co, Jason C. Limcaco, Hans Calvin L. Tan, Maria Regina Justina E. Estuar, Ph.D., Christian Pulmano, M.S., Dennis Villamor, M.S., Quirino Sugon, Ph.D., Maria Cristina G. Bautista, Ph.D., Paulyn Jean A. Claro, Ph.D.

Ateneo de Manila University, Quezon City, 1108, Philippines

Abstract

The use of electronic medical records (EMRs) plays a crucial role in the successful implementation of the Universal Healthcare Law which promises quality and affordable healthcare to all Filipinos. Consequently, the current adoption of EMRs should be studied from the perspective of the healthcare provider. As most studies look into use of EMRs by doctors or patients, there are very few that extend studies to look at possible interaction of doctor and patient in the same EMR environment. Understanding this interaction paves the way for possible incentives that will increase the use and adoption of the EMR. This study uses process mining to understand simulated doctor-patient interaction, with the goal of developing interaction features and a token economy framework to increase EMR adoption. Results from the process mining showed that current EMR interaction remains low, and highlighted the need for interaction features to promote preventive healthcare. Moreover, process mining from the simulated logs showed that consistency and time are important factors in encouraging usage. Activity category, relative frequency of activity, relative case frequency of activity and average time spent on activity are features that may serve as the foundation for a token economy framework for EMRs.

Keywords: Token Economy; Blockchain; Healthcare; Electronic *Medical* Records; Process Mining.

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Co-Design of a routine that implements an equity and quality checklist to vulnerable elders on primary care: a living lab approach

Magda Almeida[a], Adriana Taveira[a], Ana Macedo[b,c], José Crispim[d]

[a]*Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
[b]*Unidade de Investigação das Ciências da Saúde: Enfermagem (UICISA: E), Escola de Enfermagem de Coimbra (ESEnfC), Portugal.*
[c]*Escola de Enfermagem, Universidade do Minho, Portugal.*
[d]*NIPE, Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal*

Abstract

The population structure is changing. The proportion of elderly who is at risk of functional decline or death in a period of two years, the vulnerable elders, is rising. In this way, primary health care must incorporate quality and equity instruments that favor a better care provision. This study aims at co-designing the content, functionality, and interface modalities of an Equity and Quality Checklist to support the management of vulnerable elder patients in primary health care. The living labs approach involved multiple stakeholders: physicians, nurses, managers, and information technology developers assuming different roles in the context of a real environment. The decision-making process and the rationality of the choices made during the co-design workshops for the mockups and prototype is explained. The routine developed can be added to existing clinical information systems, and according to the participants will have a high impact on the care of vulnerable elders.

Keywords: Vulnerable elder, living lab, clinical information system, primary care, equity, quality indicators.

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COVID-19 BR: A web portal for COVID-19 information in Brazil

Isabelle Carvalho[a], Filipe Andrade Bernardi[b,c], Mariane Barros Neiva[a], Vinícius Costa Lima[b,c], Lariza Laura de Oliveira[b], Newton Shydeo Brandão Miyoshi[b], Tiago Lara Michelin Sanches[b], Francisco Barbosa-Junior[b], Nathalia Yukie Crepaldi[b], Diego Bettiol Yamada[b], Domingos Alves[b]

[a]*Institute of Mathematical and Computer Sciences, University of Sao Paulo, Av Trabalhador Sao-Carlense 400, 13566590, Sao Carlos/SP, Brazil*
[b]*Ribeirão Preto Medical School, University of Sao Paulo, Av Bandeirantes 3900, 14049900, Ribeirao Preto/SP, Brazil*
[c]*São Carlos School of Engineering, Av Trabalhador Sao-Carlense 400, 13566590, Sao Carlos/SP, Brazil*

Abstract

Brazil is a large developing country that requires attention to regionalized behaviors regarding the dissemination of COVID-19. To deal with this complexity, the COVID-19 Brazil observatory was developed. The Portal aims to monitor and analyze data from different sources. Therefore, with a detailed audit, we centralized this information on the evolution of the disease, allowing for territorial and temporal monitoring. The daily publication of numbers about COVID-19 allowed anyone to follow the current scenario in several Brazilian cities. With about 1,7 million accesses, the Portal offers clarity and an easy understanding of the pandemic data in the country.

Keywords: COVID-19; Data Mining; Knowledge Discovery; Mathematical Models; Public Health

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COVID-19 Time Series Forecasting – Twenty Days Ahead

Kathleen C. M. de Carvalho [a,b], João Paulo Vicente [a,b], João Paulo Teixeira [a]

[a] *Research Centre in Digitalization and Intelligent Robotics (CEDRI), Instituto Politecnico de Bragança, Braganca, Portugal*
[b] *Federal University of Technology - Paraná (UTFPR), Cornélio Procópio, 86300-000, Brazil*

Abstract

The new Coronavirus, responsible for the COVID-19 disease, is the most discussed topic in the current days, and the forecast numbers of new cases and deaths are the most important source of data in governmental decision-making. The present work presents a prediction model with two different approaches concerning the input data, by using Artificial Neural Networks (ANN). The use of a substantial mitigation procedure adopted (mandatory use of masks) was experimented as an input to the network, in order to evaluate the improvement in the results. The ANN forecasting model was demonstrated to predict with higher accuracy within the next twenty days using the information about the mandatory use of face masks. The final results showed that the twenty days ahead forecasting was made with an error of 24,7% and 1,6% for the number of cumulative cases of infection and deaths for Brazil, and 37,9% and 33,8% for Portuguese time series, respectively.

Keywords: Brazil COVID-19 forecasting; Portugal COVID-19 forecasting; COVID-19 time series; Mitigation procedures; Use of face masks.

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Data warehouse for machine learning: application to breast cancer diagnosis

Marwa Ben Ammar[a], Faten Labbene Ayachi[a], Riadh Ksantini[b], Halima Mahjoubi[c]

[a]Higher Institute of Medical Technologies of Tunis (ISTMT) Tunis El Manar University, Tunisia
[b]Digital Security Research Unit - Higher School of Communication of Tunis (SUPCOM), University of Carthage, Tunisia
[c]College of IT, University of Bahrain, Bahrain

Abstract

The diagnosis and treatment of breast cancer are very much studied in the field of medical research. Indeed, the early detection of this pathology allows for the best possible treatment and minimization of the after-effects. The business process "Diagnosis of breast cancer in women" is perfectly mastered by the practitioner and the medical profession and is widely documented in the literature. We propose a vision of “analysis of the existing” which allows to discover this process to the computer engineer in charge of the implementation of a system for aid in diagnosis and prognosis of the disease. This step is indispensable to discover the data generated during the business process and to discover in a later step all the characteristics that govern the disease. We define a system of diagnosis and prognosis of the disease Diaprog which uses the data of the classified and archived care records. We say that we use the historical data generated during the main process. We distinguish for this purpose between a production database and a data warehouse. The latter is a database fed from the various production databases accessible and made available in our system. In the case of our work, we call this data warehouse DDA (Diagnosis Data Archive). The data warehouse thus defined is a component of the medical diagnosis aid system Diaprog whose functional architecture also implements a learning module that allows the discovery of relationships between the characteristics that govern the disease.

Keywords: Breast cancer diagnosis, Patient career, data warehouse, Structured Data.

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Deep Learning Models for Intracranial Hemorrhage Recognition: A comparative study

Mohammed Ammar[a], Mohamed Amine Lamri[a], Saïd Mahmoudi[b], Amel Laidi[a]

[a]*Engineering Systems and Telecommunication Laboratory, University M'Hamed Bougara, Boumerdes, Algeria*
[b]*University of Mons, Faculty of Engineering, Computer Science Department. 20 Place du parc, Mons, B-7000, Belgium*

Abstract

Every day, a large number of people with brain injury are received in the emergency rooms. Due to the large number of slices analyzed by the doctors for each patient and to accelerate the diagnosis, the development of a precise computer-aided diagnosis system becomes very recommended.
The aim of our work is developing a tool to help radiologists in the detection of intracranial hemorrhage (ICH) and its five (05) subtypes in computed tomography (CT) images. Five deep learning models are tested: ResNet50, VGG16, Xception, InceptionV3 and InceptionResNetV2. Before training these models, preprocessing operations are performed like normalization and windowing.
The experiments show that VGG-16 architecture provides the best performances. The model achieves an accuracy of 96%.

Keywords: Intracranial Hemorrhage; CT; Detection; Classification; Deep Learning; VGG-16.

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Design and Implementation of Medical Searching System Based on Microservices and Serverless Architectures

Jawad Sadek[a], Dawn Craig[a], Michael Trenell[b]

[a]*NIHR Innovation Observatory , Newcastle University, Newcastle, UK*
[b]*Faculty of Medical Sciences Newcastle University, Newcastle, UK*

Abstract

Microservices and Serverless computing are promising cloud-based architectural models in the software development industry that have many advantages over previous technology models. The benefit of adopting these more novel models, however, is dependent on the volume of the application workload and the execution behavior. ScanMedicine is a new searching system dedicated to providing health care professionals, patients and researchers with easy access to intelligence underpinning health technology innovations. We present the design and implementation of ScanMedicine's framework using AWS lambda functions and microservices. We incorporated a layered architectural style where each layer run on separate hardware and adopt different architectural technique.

Keywords: Microservices, Serverless, Cloud Computing, AWS, Clinical Trials, Medical Devices.

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Developing a Process Mining Tool Based on HL7

João Coutinho-Almeida[a], Ricardo João Cruz-Correia[b]

[a]CINTESIS - Centre for Health Technologies and Services Research, University of Porto, Portugal
[b]MEDCIDS – Faculty of Medicine of University of Porto, Portugal

Abstract

In healthcare facilities, processes are not always carried out under the expected methods. The variation in practice leads to lesser quality treatments and greater costs. Within a single visit, patients are now likely to interact with multiple departments, healthcare providers, and Health Information Systems (HIS). Because of these events, information is frequently dispersed, not normalized, and incoherent, creating several barriers to overview processes and audit their quality. Process mining can be a useful tool for getting over some of these obstacles. We designed a procedure to automatically apply process mining techniques using the HL7 standard, which is used for exchanging information between HIS, as a source of event logs. Our work provides a way for pooling HL7 messages from a unified repository of a healthcare institution and provides a pipeline to apply process mining methods to create insights relative to the healthcare processes that are implemented. We show a few diagrams to demonstrate the tool's potential as a process formalization and analysis tool. We concluded that using HL7 messages as a proxy for processes that involve several HIS is a way to easily provide process mining capabilities to an organization.

Keywords: process-mining; healthcare; data mining; HL7; event log.

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EatLOCAL: a platform that connects local farmers, consumers, municipalities and non-governmental organisations

Rafaela Bastos Fortunato[a], Ana Rute Araújo Monteiro Zina[a], Samantha Breyer[a], Diana Filipa Malias Paulino[a], Carolina Santos[a.b,c]

[a]*National School of Public Health, Universidade NOVA de Lisboa, Avenida Padre Cruz, Lisbon 1600-560, Portugal*
[b]*NOVA National School of Public Health, Public Health Research Centre, Universidade NOVA de Lisboa*
[c]*Comprehensive Health Research Centre - Universidade NOVA de Lisboa*

Abstract

The COVID-19 pandemic has brought unprecedented challenges to public health and supply chain systems around the globe. Local farmers businesses were impacted by the lockdowns and they still face difficulties in commercializing their production while requests for social, economic and food support pile up at municipalities and non-governmental organisations (NGOs). Meanwhile, working from home, constraints to workout, business and social life, are impacting citizens' work-life balance, eating habits and impacting populations' physical and mental health globally. *EatLOCAL* proposes to address this issue by providing a service that is supported in an innovative digital platform that strengthens connections between suppliers, consumers, municipalities and NGOs working on food privation issues. Besides maximizing the opportunities for business to local farmers, this platform also creates a facilitated channel that promotes de access to fresh food by citizens and minimizes the social impact of the pandemic in most vulnerable groups.

Keywords: social entrepreneurship; food insecurity and privation; supply chain; social determinants of health.

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Enactive methods towards situational learning - engaging people with intellectual and developmental disability in design

Lise Amy Hansen[a], Sofie Wass[b]

[a]*The Oslo School of Architecture and Design, Oslo, Norway*
[b]*University of Agder, Grimstad and Kristiansand, Kristiansand, Norway*

Abstract

In this paper we explore how enactive methods may support and enhance the design of mobile solutions for people with intellectual and developmental disabilities. Our project deals with supporting independent public transport and applies enactive methods in order to account for the interdependent nature of technology, disability, and environment. We staged three iterations of a bus workshop and one theatre workshop where real, everyday scenarios were acted out to gain tacit yet crucial insights. These enactive workshops and the prototype testing showed that transport activities are context dependent and unique to each individual. In our case, enactive methods revealed that independent public transport goes beyond a need for reminders, time management and communication, towards the management of unforeseen events. Our work shows how a closer realistic setting may provide more nuanced, personal, and detailed design insights that support emotional and situational understandings of user experiences.

Keywords: Enactive Methods; User Experience Design; Assistive Technologies; Transport.

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Evaluation of Mobile Health apps for Non-Medical Cannabis Use: A Scoping Review

Hayat Sedrati[a,b], Zakaria Belrhiti[b], Chakib Nejjari[c,d], Hassan Ghazal[d,e]

[a]*Mohammed V University in Rabat, National School of Computer Sciences and Systems Analysis, Rabat, Morocco*
[b]*National School of Public Health, Rabat, Morocco*
[c] *Department of Epidemiology and public Health, Faculty de medicine, University Sidi Mohammed Ben Abdellah, Fez, Morocco*
[d] *School of Medicine, Mohammed VI University of Health Sciences, Casablanca, Morocco*
[e]*National Centre for Scientific and Technical Research, Rabat, Morocco*

Abstract

Cannabis use represents the most commonly illicit drug intake worldwide. m-Health interventions have the potential to play a key role in the fight against cannabis intake issues. A steadily increasing number of m-Health apps are currently available on commercial app stores to support psychoactive substance users. This study aims at exploring technical and functional characteristics of available m-Health-apps intended for non-medical Cannabis Use and Dependence (CUD). We carried out a scoping review following guidance from Arksey & O'Malley. We searched in Pubmed, Scopus and Web of Science databases end of March 2021. Only five papers fitted our inclusion criteria out of 113 studies. Four out of five included studies reported a decrease of cannabis use and adequate feasibility and acceptability of m-Health apps. Most of these studies used self-reported questionnaires. More studies are need to rigourously assess the usability and effective of m-Health apps for CUD.

Keywords: cannabis, m-Health, mobile app, usability.

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Face masks on Instagram: an analysis of public health authorities' guidance toward prevention

Pâmela Araujo Pinto[a], Fellipe Sá Brasileiro[b], Maria João Lopes Antunes[a], Ana Margarida Pisco Almeida[a]

[a]*DigiMedia/Department of Communication and Art/University of Aveiro, Aveiro, 3810-193, Portugal.*
[b]*Communication Department/ Federal University of Paraíba, João Pessoa, 58051-900, Brazil.*

Abstract

Instagram (IG) has been used as a health promotion tool by national and international sanitary authorities to tackle COVID-19. The profile of the World Health Organization (WHO) on IG contributed to spread and update information on the new coronavirus prevention This study focus attention on a non-pharmaceutical control measure (face mask in the community) and discusses the adaptation of health authorities from Portugal and Brazil to WHO guidelines on this topic, and how they passed them to citizens. A content analysis of posts from WHO, Portuguese National Health Service (NHS), and the Brazilian Ministry of Health (MH) profiles on IG was carried out, in the first 100 days of the pandemic. The sample is composed of 65 posts - WHO (12), NHS (36) and, MH (17). NHS highlights masks in 8,8% of posts and MH in 3,3%. WHO guidelines followed scientific evidence and prioritized the surgical masks, while NHS and MH adapted the guidelines to regional scenarios (community transmission and difficulty to social distancing) and produced information on non-surgical masks. NHS recommends the use of certified non-surgical masks. MH diverged from WHO guidelines and advised cloth masks. NHS has adopted the preventive approach and the use of celebrities to stress the importance of following its guidelines. MH adopted an institutional approach to encourage adherence to the instructions. Both profiles offered incomplete content on the production, use, disposal, and maintenance of masks.

Keywords: Public Health; COVID-19; Face Mask; Health Authorities; Social Media.

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How to Improve Emergency Information Systems to Optimize the Care of Acute Stroke

Lígia Fernandes[a],Diana Santos[a],Milton Santos[b], Nelson Pacheco Rocha[c]

[a]*University of Aveiro, Aveiro 3810-193, Portugal*
[b]*IEETA, Health Sciences School, University of Aveiro, Aveiro 3810-193, Portugal*
[c]*IEETA, Department of Medical Sciences, University of Aveiro, Aveiro 3810-193, Portugal*

Abstract

The quality of the healthcare provided in the context of cerebrovascular accident (stroke) is closely linked to the celerity of the diagnosis, so the action of health professionals must be coordinated, and all the processes should proceed as quickly, efficiently, and effectively as possible. In turn, the crowding of emergency services contributes for considerable high delay times. The research study reported by this paper aimed to identify features to include in the emergency services information systems to improve the contribution of the medical imaging within acute stroke diagnosis and treatment. Medical imaging processes related to Head Computed Tomography and Angio Computed Tomography in a medium-size Portuguese were analyzed to identify possible improvements. Moreover, semi-structured interviews were conducted involving a group of health care professionals with experience in pre- and intra-hospital emergency services to identify the needs that can be satisfied with innovative technological solutions and to assess the viability to introduce additional features in the information systems supporting the emergency services. The results show that additional features might be considered to improve acute stroke diagnosis and treatment and the health care professionals are receptive to these improvements.

Keywords: Stroke; Emergency services; Imaging Services; Clinical Workflow; Clinical Data; Process Improvement.

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Integrated privacy decision in BPMN clinical care pathways models using DMN

Intidhar ESSEFI [a], Hanene BOUSSI RAHMOUNI[b], Mohamed Fethi LADEB[c]

[a]*Higher Institute of Medical Technologies of Tunis (ISTMT) Tunis El Manar University, Tunisia*
[b]*University of the West of England, the Computer Science Research CenterBristol, UK*
[c]*Radiology Department, Kassab Orthopedics Institute, Manouba, Tunisia*

Abstract

Personal data is highly affected by the witnessed digital transformation of healthcare processes. This process relies deeply on the connectivity and decentralization of healthcare systems and data repositories. In this context, value creation and quality enhancement are obviously leveraged, however both health providers and individuals could be exposed to many risks ranging from privacy violations to medical identity theft and personal harm. Hence, it is essential that healthcare stakeholders ensure privacy protection and systemic compliance to personal data regulations such as HIPPA (Health Insurance Portability and Accountability Act) and GDPR (General Data Protection Regulation). Taking clinical processes as a starting point is very important to highlight the personal data in use and to assess whether such usage is justifiable and subsequently allow privacy management decisions to be made. In this paper we combine BPMN (Business Process Model and Notation) and DMN (Decision Model and Notation) to model clinical care pathways as standard business processing constituting the hospital information system. Business process modelling presents a useful mean to model clinical care pathways. It allows a complete discovery of data processing scenarios. DMN (Decision Model and Notation) is implemented in BPMN models to present the rules that lead to a decision in easy-to-read tables which are executed directly by a decision engine. In addition, the integration of verifiable security labels of the manipulated data, we make sure compliance to legislation is ensured at the level of decision rules for each decision table of the DMN.

Keywords: BPMN, care pathways, Digital transformation, DMN, GDPR, HIPAA, protection methods, security labels, sensitive data.

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Machine Learning automatic assessment for glaucoma and myopia based on Corvis ST data

Danilo Leite[a,b], Maria Campelos[c], Ana Fernandes[c], Pedro Batista[c,e], João Beirão[c,e], Pedro Menéres[c,e], António Cunha[c,f]

[a] *Empresa Brasileira de Serviços Hospitalares- Ebserh, Paraíba, Brasil*
[b]*Universidade Federal da Paraíba, Paraíba, Brasil*
[c]*Universidade de Trás-os-Montes e Alto Douro, Vila Real 5000-80, Portugal*
[d]*Instituto de Ciências Biomédicas Abel Salazar, Porto 4050-313, Portugal*
[e]*Centro Hospitalar Universitário do Porto, Porto 4099-001, Portugal*
[f]*Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência,Porto 4200-465, Portugal*

Abstract

Glaucoma is a silent disease characterized by progressive degeneration of retinal ganglion cells and, when not detected or treated early, can lead to blindness. Computer systems have demonstrated their efficiency in the medical decision-making process and Artificial Intelligence (AI) techniques have helped advances in ophthalmology, allowing for faster and more effective detection of glaucoma. Machine learning is a very promising subfield of AI that supports research in understanding the development, progression and treatment of glaucoma, identifying new risk factors and assessing the importance of existing ones.
This study aims to test and analyze the results of different models of supervised machine learning in the detection and classification of ophthalmic diseases (Glaucoma, high myopia and low myopia) based on data from Corvis ST. The most important characteristics were selected based on a variance greater than 0.02. In terms of accuracy, the models that obtained the best results were Random Forrest 0.73, Stochastic Gradient Descent (SGD) 0.75, Gradient Boosting Classifier (GBC) 0.76 and K-Nearest Neighbors 0.71. The GBC model achieved the best results in accuracy, AUC, Recall and F1Score 76.00, 52.5, 78.00, 70.2 respectively.

Keywords: Corvis ST; Machine Learning; Glaucoma; Cornea dynamics.

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Medical Imaging Repository Contributions for Radiation Protection Key Performance Indicators

Milton Santos[a], Nelson Pacheco Rocha[b]

[a]*IEETA, Health Sciences School, University of Aveiro, Aveiro 3810-193, Portugal*
[b]*IEETA, Department of Medical Sciences, University of Aveiro, Aveiro 3810-193, Portugal*

Abstract

The data stored in the different information systems supporting the medical imaging departments are crucial for de development of Performance Key Indicators (KPI), namely in the radiation protection scope. One of the data sources pertinent for the development of these KPI, is the Digital Imaging and Communication in Medicine (DICOM) metadata related to medical imaging studies stored in Picture Archiving and Communications Systems (PACS). The study reported by this paper aimed to evaluate the adequacy of DICOM metadata stored in a healthcare institution PACS to implement some KPI related to radiological protection suggested by the European Society of Radiology and the European Federation of Radiographer Societies. Data produced by 30 medical imaging devices from different manufactures related to six medical modalities (i.e., Computed Tomography, Computed Radiography, Digital Radiography, X-Ray angiography, Radio Fluoroscopy and Mammography) were analyzed. Although, a significant number of KPI can be supported by DICOM metadata, the respective compliance depends on each modality image IOD. As future work, strategies must be defined to allow access and aggregation of public and private DICOM attributes as well as attributes of the Radiation Dose Structured Report and other hospital information systems for the development of KPI to reliably characterize the exposure to ionizing radiation during medical imaging studies.

Keywords: DICOM, Key Performance Indicators, Radiation Protection, PACS, Medical Imaging.

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Medication quality and work practice

Camilla Bjørnstad[a], Gunnar Ellingsen[b]

[a]*Norwegian Centre for E-Health Research, P.O.Box 35, 9038 Tromsø, Norway*
[b]*UiT, The Arctic university of Norway, O.O.Box 6050, 9037 Tromsø, Norway*

Abstract

Supported by digital systems, closed loop medication management (CLMM) is considered an essential method to improve the quality of medication management in hospitals. This includes electronic ordering, verifying, preparing and administering medication. However, healthcare has so far seen very few fully working solutions of CLMM. We therefore pose the research question: What is the nature, challenges and consequences of CLMM in hospitals? We find that CLMM is highly resource demanding and implies a lot of engagement and workaround by health personnel. While some workaround are expected, we find that others may jeopardize patient safety. The paper contributes with an understanding and conceptualization of CLMM and proposes socio-technical strategies for using digital tools to increase the quality of the medication management process. Theoretically, we draw on the concept of information infrastructures, work practice perspectives and work system theory. Empirically, we present a study of the first hospital in Norway to have implemented CLMM.

Keywords: Closed loop medication management; barcode; medication; work practice; workaround; electronic medication management system.

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Mental health indicators in the hospitalization process in a Brazilian psychosocial care network

Inacia Bezerra de Lima[a], Domingos Alves[b], Andre Luiz Teixeira Vinci[b], Rui Pedro Charters Lopes Rijo[c], Ricardo Martinho[c], Diego Bettiol Yamada[b], Filipe Andrade Bernard[b], Antonia Regina Ferreira Furegato[a]

[a] *School of Nursing of Ribeirão Preto, University of São Paulo, Ribeirao Preto, Brazil*
[b] *Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, Brazil*
[c] *School of Technology and Management, Polytechnic Institute of Leiria, Leiria, Portugal*

Abstract

We aim to present the use and viability of mental health indicators at a Brazilian reference psychiatric hospital. We elaborated a Business Process Model and Notation based model of the patients' hospitalization process based on semi-structured interviews with managers and professionals of the hospital. We analyzed the model and selected a set of 6 mental health indicators, based on evidence-based practice from other countries, using information from several Health Information Systems regarding hospitalizations from 2013 to 2017. In Brazil, there is a lack of methods for the manager to measure the actions carried out in mental health. Thus, the method proposed in this article can be used as metrics to assess the impact of public policy implementation and to assist planning and decision-making based on evidence in mental health.

Keywords: Basic health indicators; Mental health services; Health services administration; Health Information Systems; Business Process Management.

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My Latent Tuberculosis Treatment - mobile application to assist in adherence to latent tuberculosis treatment

Thomaz Felipe Soares Arnizant[a], Filipe Andrade Bernardi[a,b], Tiago Lara Michelin Sanchez[a], Nathalia Yukie Crepaldi[a], Thiago Nascimento do Prado[c], Marcelle Temporim Novaes[c], Ethel Leonor Noia Maciel[c], Domingos Alves[a]

[a]*Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, Brazil*
[b]*Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil*
[c]*Espírito Santo Federal University – Epidemiology Laboratory, Vitória, Brazil*

Abstract

According to the World Health Organization (WHO), latent tuberculosis occurs through latent infection by Mycobacterium tuberculosis without evidence of active tuberculosis (TB) symptoms. As patients don't develop the same symptoms as active TB, the treatment is abandoned before the end, as it lasts about six months. This leads to significant treatment avoidance, requiring new forms of adherence to latent TB treatment. One of the strategies to help to latent TB treatment is the possibility of using applications for mobile devices, once the use of ICTs to aid in the treatment of LTBI can increase the rate of treatment adherence. Thus, this work aimed to study the creation of a technology that helps the adherence of these patients, being made available an application that is easy to use, intuitive, free and developed in a language for Android phones, which accompany the patient throughout the treatment.

Keywords: latent tuberculosis; mobile app; mHealth.

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Optic disc and cup segmentations for glaucoma assessment using cup-to-disc ratio

Alexandre Neto[a,c], José Camera[b,c], Sérgio Oliveira[a], Ana Cláudia[a], António Cunha[a,c]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real 5000-80, Portugal*
[b]*Universidade Aberta, Lisboa 1250-100, Portugal*
[c]*Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência, Porto 3200-465, Portugal*

Abstract

Glaucoma is a silent disease that shows symptoms when severe, leading to partial vision loss or irreversible blindness. Early screening permits treating patients in time. For glaucoma screening, retinal images are very important since they enable the observation of initial glaucoma lesions, which typically begins with the cupping formation in the optic disc (OD). In clinical settings, practical indicators such as Cup-to-Disc Ratio (CDR) are frequently used to evaluate the presence and stage of glaucoma. The ratio between the cup and the optic disc can be measured using the vertical or horizontal diameter, or the area of the two. Mass screening programs are limited by the high costs of specialised teams and equipment. Current deep learning (DL) methods can assist the glaucoma mass screening, lower the cost and allow it to be extended to larger populations. With DL methods in the OD and optic cup (OC) segmentation, is possible to evaluate the presence of glaucoma in the patient more quickly based on cupping formation in the OD, using CDR.
In this work, is assessed the contribution of Multi-Class and Single-Class segmentation methods for glaucoma screening using the 3 types of CDR. U-Net architecture is trained using transfer learning models (Inception V3 and Inception ResNet V2) to segment the OD and OC and then evaluate glaucoma prediction based on different types of CDRs indicators. The models were trained and evaluated on main public known databases (REFUGE, RIM-ONE r3 and DRISHTI-GS). The segmentation of both OD and OC reach Dice over 0.8 and IoU above 0.7. The CDRs were computed to glaucoma assessment where was reach sensitivity above 0.8, specificity of 0.7, F1-Score around 0.7 and AUC above 0.85. Finally, conclusions of segmentation methods showing adequate performance to be used in practical glaucoma screening.

Keywords: Glaucoma; Segmentation; Cup-to-disc ratio; Screening.

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Ovarian Structures Detection using Convolutional Neural Networks

Macro Diego Wanderley[a], Carlos Ferreira[a,b], Aurélio Campilho[a,b,], Jorge Silva[a,b]

[a]*Faculty of Engineering of the University of Porto (FEUP), Porto, Portugal*
[b]*Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Porto, Portugal*

Abstract

The detection of ovarian structures from ultrasound images is an important task in gynecological and reproductive medicine. An automatic detection system of ovarian structures can work as a second opinion for less experienced physicians or complex ultrasound interpretations. This work presents a study of three popular CNN-based object detectors applied to the detection of healthy ovarian structures, namely ovary and follicles, in B-mode ultrasound images. The Faster R-CNN presented the best results, with a precision of 95.5% and a recall of 94.7% for both classes, being able to detect all the ovaries correctly. The RetinaNet showed competitive results, exceeding 90% of precision and recall. Despite being very fast and suitable for real-time applications, YOLOv3 was ineffective in detecting ovaries and had the worst results detecting follicles. We also compare CNN results with classical computer vision methods presented in the ovarian follicle detection literature.

Keywords: follicle detection; ovary detection; ovarian structures, gynecological ultrasound; convolutional neural networks.

Full paper available online at SciVerse ScienceDirect (www.sciencedirect.com).

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Polyps Detection in Colonoscopies

José Ribeiro[a], Sara Nóbrega[a], António Cunha[a,b]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[b]*INESC TEC – INESC Technology and Science, Porto, 4200-465, Portugal*

Abstract

A colonic polyp is a growth in the lining of the colon or rectum and can be detected through colonoscopies. The efficiency of colonoscopies depends on the number of polyps detected. However, detecting and classifying polyps is difficult, tedious, and prone to error. Knowing that this process's performance is far from perfect, the objective of this project is to help colonoscopists in the detection of polyps during the medical intervention, using Deep Learning (DL) alongside the image recognition capabilities of Convolutional Neural Networks (CNN) models that can process colonoscopy images at high speed in real-time.
In this paper, were tested different state-of-the-art CNNs using a transfer learning approach, achieving an average accuracy of 95,70% in the polyp detection task. Multiple public datasets were used in this study to train, test, and evaluate the classifiers. The negative class included images representative of healthy tissue as well as other pathologies, so the models would not mistake other diseases as polyps.

Keywords: Deep Learning; Convolutional Neural Networks; Colorectal Cancer Prevention; Colon polyps; Polyp detection.

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Protective Equipment Applicable to a Centralized Cytostatic Preparation Unit

Ana Gonçalves[a], Rui A. F. de Oliveira[a], Paula Odete Fernandes[b]

[a]Instituto Politécnico de Bragança; Campus de Santa Apolónia, 5300-253, Bragança, Portugal
[b]Applied Management Research Unit (UNIAG); Instituto Politécnico de Bragança; Campus de Santa Apolónia, 5300-253, Bragança, Portugal

Abstract

Occupational exposure to cytotoxic agents has been recognized as a potential danger to the health of handlers. However, collective and individual protection equipment has been developed for use by professionals. This article aims to identify and describe the protection equipment applicable to a centralized unit of cytostatics preparation, using a qualitative and quantitative descriptive analysis. A questionnaire survey yielded 83 responses, covering 18 centralized cytostatic preparation units. The results show some weaknesses detected in some institutions such as the absence of a shower and eyewash fountain, the lack of knowledge about the procedures manual, and the use of a surgical mask. However, the results point to awareness by the general manipulators regarding the use of some personal protective equipment. This study contributes to the investigation of the use of equipment for the protection of cytostatic manipulators at work in centralized cytostatic preparation units.

Keywords: Centralized cytostatic preparation unit; Individual and collective protective equipment; cytostatic drugs, guidelines.

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Reasoning about bladder cancer treatment outcomes using clinical trials within a knowledge-based clinical evidence approach

Chamseddine Barki[a], Hanene Boussi Rahmouni[a,b], Salam Labidi[a]

[a]University of Tunis el Manar, The Higher Institute Of Medical Technologies of Tunis, Research Laboratory of Biophysics and Medical Technologies, Tunis 1006, Tunisia
[b]University of the West of England, The Computer Science Research Centre, Bristol, UK

Abstract

Side effects (SEs) and adverse events (AEs) of bladder cancer (BC) treatment have become more prevalent and may impact the effectiveness of the prescribed therapy. Given, the substantial combination of various treatment types and interventions, it is crucial for the urologist and the team of specialists to discern the systematic and local SEs of these treatments for more awareness and vigilance. This was shown within randomized clinical trials (RCTs) which are complex, and their management needs many efforts. RCTs generate a big amount of knowledge that can serve as evidence for future clinical decision making. Current approaches do not discuss semantic integration of different resources. In this paper we propose a knowledge-based BC treatment effects and complication infrastructure (BCTECI) approach to reason and appraise the effectiveness of BC treatments within their related SEs. This optimized treatment outcomes. Referring to ontology features, a knowledge model with semantic queries and logic rules included evidence concluded from the assessed RCTs. Hence, this supports interoperability between RCTs resources and a common treatment ontology. For this, a comprehensive literature search of relevant RCTs was performed systematically in different electronic medical databases. All pertinent RCTs covering BC treatment cases and reporting prescriptions' effectiveness were included in BCTECI knowledge model. This study provided the required taxonomy and semanticization and evaluated the effectiveness of treatment outcomes. Furthermore, it extended the clinical evidence-based knowledge for AEs anticipation with a more efficient treatment prescription and showed whether SEs impact the effectiveness of a prescribed treatment until revocation.

Keywords: Adverse events; bladder cancer, efficacy; knowledge; protocol; randomized controlled trial; safety; side effects; treatments

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STEMI-CR: Solution for Patients with Acute Myocardial Infarction at Home-Based Cardiac Rehabilitation Program

Pinheiro Candjondjo[a,b], Elisabete Vaz[a], Sara Marques[a], José Moreira[a,c]

[a]*National School of Public Health, Universidade NOVA de Lisboa, Avenida Padre Cruz, Lisbon 1600-560, Portugal*
[b]*Hospital de São Bernardo, Centro Hospitalar de Setúbal, Rua Camilo Castelo Branco, Setúbal 175, 2910-549, Portugal*
[c]*Portuguese Oncology Institute of Lisbon, Rua Professor Lima Basto, Lisbon 1099-023, Portugal*

Abstract

STEMI - CR (ST Elevation Myocardial Infarction - Cardiac Rehabilitation) is a program based on a model of home monitoring through digital tools (mobile application and website) in patients who have suffered acute myocardial infarction. This solution found in information technology will be used to address the delivery of services with remote operation between patients and health professionals and allows the delivery of home services through a cardiac recovery program in post-myocardial infarction patients through the automation of PROM's (Patient Reported Outcomes Measures) and biometric/electrocardiographic data monitored in real time, which can be incorporated into the hospital clinical record. The platform brings together several resources, such as exercise prescription, diet and medication, monitoring exercise plan, prescription history and recording the symptom. It will also be possible to have an avatar, gamification challenges and a communication area (social network), so that patients included in the program can enhance interaction and share their experiences about the various recommended activities and their impact on quality of life. It is based on this conception that any pharmacological and non-pharmacological guidelines can be based, with the expectation of greater patient adherence to CR programs and a significantly impact on the respective prognosis.

Keywords: Cardiac Rehabilitation; Acute Myocardial Infarction.

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TBI Score - use of a mobile score system to aid the diagnosis of tuberculosis in children in Brazil

Filipe Andrade Bernardi[a,b], Vinicius Costa Lima[a,b], Danilo Maglio Sampaio[b],Marcelo Cordeiro dos Santos [cd], Rui Pedro Charters Lopes Rijo[befg], Domingos Alves[bg]

[a]Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil
[b]Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, Brazil
[c]Carlos Borborema Clinical Research Institute, Dr. Heitor Vieira Dourado Foundation for Tropical Medicine, Manaus, Brazil
[d]Tropical Medicine Postgraduate Program, Amazonas State University, Manaus, Brazil
[e]School of Technology and Management, Polytechnic Institute of Leiria, Leiria, Portugal
[f]INESCC - Institute for Systems and Computers Engineering at Coimbra, Coimbra, Portugal
[g]Center for Research in Health Technologies and Services (CINTESIS), Faculty of Medicine, University of Porto, Porto, Portugal

Abstract

Tuberculosis (TB) is a bacterial infectious disease that mainly affects the lungs and remains as one of the biggest public health problems in the world. The treatment methods currently available can cure almost all cases. Due to the difficulty of bacteriological confirmation of TB in children, the Brazilian Ministry of Health recommended the use of a scoring system for the diagnosis of pulmonary TB in childhood, covering aspects of clinical, radiological and epidemiological data. The general objective of this work is the development and availability of a mobile application based on the score described in the Manual of Recommendations for TB Control in Brazil. The application was organized to make the questionnaire flow linear, while maintaining the accordance with the structure presented in the manual. The score adapted to the Brazilian context allows health professionals to underpin their decisions with reliable information.

Keywords: childhood tuberculosis; digital health; mobile applications; public health.

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The minimum dataset for rare diseases in Brazil: a systematic review protocol

Filipe Andrade Bernardi[a,b], Diego Bettiol Yamada[b], Bibiana Mello de Oliveira[c], Vinicius Costa Lima[a,b], Têmis Maria Félix[d], Domingos Alves[b]

[a]*Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil*
[b]*Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, Brazil*
[c]*Postgraduate Program in Genetics and Molecular Biology, Federal University of Rio Grande do Sul, Porto Alegre, Brazil*
[d]*Medical Genetics Service, Porto Alegre Clinics Hospital, Porto Alegre, Brazil*

Abstract

The Minimum Data Set (MDS) can be used for subsidiarity decision-making and health planning. Besides, this strategy allows to identify obligatory points that must be adjusted to achieve sustainable management in the planning and development of relevant Health Information Systems for public health. Specifically, in the context of rare diseases, the MDS strategy can be very valuable. This systematic review will focus on research using MDS for rare diseases in several databases. We seek to answer the question: "What is the minimum data set used in registries for rare diseases?" Some outcomes of interests specific for MDS will involve information about epidemiology, clinical procedures, and therapeutic resources among other features. We hope that by standardizing data through a careful analysis of evidence from different sources of a common format, with shared specifications and structures, we can help in the methodological transparency and reproducibility of results in the context of rare disease research.

Keywords: Rare diseases; Minimum data set; Public Health; Digital Health; Review protocol.

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Towards a theoretical understanding of workarounds emerging from use of a referral mobile application: a developing country context

Meke I. Kapepo, Jean-Paul Van Belle, Edda Weimann

Department of Information Systems,University of Cape Town, 8001, South Africa

Abstract

Health Information Systems (HIS) in public health institutions are currently not used as intended; health care providers (HCPs) are increasingly resorting to workarounds or informal systems known as "Shadow Information Technologies" to accomplish their work. This multiple case study in three public hospitals in South Africa and Namibia describes factors driving the enactment of workarounds to the Vula mobile referral application. An interpretive paradigm was taken and semi-structured interviews conducted with 29 HCPs were analysed using a thematic analysis approach. Substantial evidence is found indicating misfits between work and use of referral applications in public hospitals. A conceptual framework is developed to explain workaround practices based on emerging concepts. The study finds that there is misfit between work and use e-referral applications in public hospitals. As a result, HCPs are enacting workarounds in a form of 1) Shadow IT (Information technology), 2) Augmenting existing systems by using alternative computer-based, telephonic and paper-based referrals 3) Fitting by adapting the e-referral application to accommodate misfits with work activities. These practices suggest a design-reality gap in failing to accommodate these issues in the e-referral application design. Additionally, these practices have brought severe security risks to clinical information used on shadow systems, compromising the privacy and confidentiality of patient information. Public health institutions therefore need to develop more effective measures, policies, and strategies to address unresolved constraints in the referral system.

Keywords: electronic eferrals; Healthcare providers; Shadow IT; Health Information systems

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Towards an Evaluation Framework for Ubiquitous, Self-Evolving Patient Identification Solutions in Health Information Systems

Ovidiu Noran, Peter Bernus

Griffith University, Nathan QLD Australia

Abstract

The increasing adoption of Health Information Systems (HIS) does not seem to have resolved the ongoing lack of ubiquitous, dependable and accurate patient information so as to effectively prevent medical errors. Previous work has identified multiple causes, including but not limited to improper or incomplete HIS implementation, incompatibility in healthcare standards, lack of proper data input and validation, and accelerating evolution of technology triggering instability of candidate solutions depending on it. This paper continues the research by describing high-level non-functional requirements that any solution should satisfy relying on current best-practice, and subsequently customizing an established international standard so as to define an evaluation framework that can be used to assess candidate HIS architectures. The ultimate aim of the research is to support selection of stable, sustainable long-term architectural solutions and thus to assist HIS strategic decision making and self-evolution supporting agility.

Keywords: health information system; healthcare standard; architecture evaluation; patient identification; non-functional requirements.

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Understanding the RFID Deployment at Sacred Heart Medical Center: Using Technology-Organization-Environment Framework Lenses

Rebecca Angeles

Faculty of Management, University of New Brunswick Fredericton, 7 Macauley Lane, Fredericton, New Brunswick E3B 5A3 CANADA

Abstract

This qualitative study based on a single case features the radio frequency identification (RFID)-based real-time location system (RTLS) system to track intravenous (IV) pumps deployed by the Sacred Heart Medical Center (SHMC), Eugene, Oregon --- one unit of the PeaceHealth network based in western U.S.A. Asset tracking management, followed by the tracking of medical staff and patients continue to be leading applications for RFID in the healthcare industry in north America. This case study uses Tornatzky's technology-organization-environment framework in interpreting and understanding the RFID deployment at SHMC/Eugene, Oregon.

Keywords: radio frequency identification (RFID); asset tracking; real-time location tracking; hospital inventory systems

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Understanding Wearing-Off Symptoms in Parkinson's Disease Patients using Wrist-Worn Fitness Tracker and a Smartphone

John Noel Victorino, Yuko Shibata, Sozo Inoue, Tomohiro Shibata

Graduate School of Life Science & Systems Engineering, Kyushu Institute of Technology, Kitakyushu, Japan 808-0196

Abstract

Parkinson's disease (PD) patients experience motor and non-motor symptoms, which affect their quality of life (QoL). Despite the use of Levodopa treatment to alleviate these symptoms, the "wearing-off phenomenon" (WO) occurs, and symptoms resurface. Thus, PD patients have to closely monitor and report their symptoms, the effects, and the duration of levodopa treatment to their doctors for a customized treatment. Towards predicting the WO among PD patients, this paper aims to understand the relationship between the WO symptoms and the collected fitness tracker data using a fitness tracker and a smartphone application. Our preliminary study among two patients within a 30-day collection period showed that PD patients experience WO symptoms with a unique relationship and association with fitness tracker datasets. The participant's sleep duration was negatively correlated with sharp pain and tremors. On the other hand, the other participant's total sleep duration was positively correlated with symptoms. Our analysis also showed that the time elapsed since the last medicine intake was a strong predictor of WO, aside from sleep duration and step count. These results suggest the possibility of using the fitness tracker dataset to estimate the WO among PD patients. The results would be helpful in the management of WO and PD in general.

Keywords: Wearing-off; Parkinson's Disease; Statistical Analysis.

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Unsupervised analysis of COVID-19 pandemic evolution in brazilian states

Victor Cassão[a], Domingos Alves[c], Ana Clara de Andrade Mioto[b], Filipe Andrade Bernardi[b], Newton Shydeo Brandão Miyoshi[a]

[a]Barão de Mauá University Center, Ribeirão Preto/SP, Brazil
[b]Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil
[c]Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, Brazil

Abstract

Extracting information and discovering patterns from a massive dataset is a hard task. In an epidemic scenario, this data has to be integrated providing organization, agility, transparency and, above all, it has to be free of any type of censorship or bias. The aim of this paper is to analyze how coronavirus contamination has evolved in Brazil applying unsupervised analysis algorithms to extract information and find characteristics between them. To achieve this goal we describe an implementation that uses data about Covid-19 spread in Brazilian states (26 states and the federal district), applying a Time Series Clustering technique based on a K-Means variation, using Dynamic Time Warping as a similarity metric. We used data reported by the Ministry of Health in Brazil, referring to deaths per 100k inhabitants, during 452 days from the first reported death in each state. Two analyzes were performed, one considering 3 clusters and the other with 6 clusters. Through these analysis, 3 patterns of responses to the pandemic can be observed, ranging from one of greater to lesser control of the pandemic, although in recent months all clusters showed a highly increase in the number of deaths. The identification of these patterns is important to highlight possible actions and events, as well as other characteristics that determine the correct or incorrect public decision-making in combating the Covid-19 pandemic.

Keywords: Time Series Clustering; Dynamic Time Warping; Unsupervised Analysis; Covid-19.

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Using Virtual Reality in the Development of an Index-Engine of Physical and Emotional Sustainability

Carlos R. Cunha [a,b], Alcina Nunes [a,b,], Paula O. Fernandes [a,b], José Bragada [a,b], Luís Pires [a,b], Maria José [c,b], Pedro Magalhães [a,b]

[a] *Applied Management Research Unit (UNIAG), Portugal*
[b] *Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal*
[c] *Mountain Research Center (CIMO), Portugal*

Abstract

Nowadays, there is a growing need for rehabilitation associated with demographic changes and health trends, with an increase in the prevalence of non-communicable diseases and an aging population. Although well-being is classically associated with a set of physical activities, the reality of today's society often shows that there is a lack of time available to develop activities that promote well-being. This fact is aggravated in aging populations by less mobility and greater isolation. In this domain, information and communication technologies have greatly contributed to helping healthcare providers to develop new understanding, measurement and action strategies that promote the physical and emotional well-being of their patients. Accordingly, the role of Virtual Reality has been shown to be promising for the generation of well-being. This article, as part of a broader funding project, reviews the state of the art of the role that Virtual Reality has played in the promotion of well-being, being an exercise of conceptualization that converges in the proposal of a conceptual model - an Index-Engine of Physical and Emotional Sustainability, which will be prototyped and field tested in the future.

Keywords: Virtual Reality; Machine Learning; Model; Emotional Sustainability; Well-being; Health.

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Clinical Decision Support System (CDSS): Systematic Literature Review (SLR) and Discussion regarding Future Research Areas

Dayaben Kansagra[1,*] MSHMI, Saurabh Gupta[2] PhD

[1,2] *Kennesaw State University, 1000 Chastain Rd, Kennesaw 30144, USA*

Abstract

Clinical decision support systems were designed with an intent to support physicians in decision making, reduce errors, and increase efficiencies. However, this promise is not always realized. This paper builds on existing reviews, updates, and presents a literature review that outlines the ambiguity in outcomes in terms of positive effect and least effect. Drawing on CDSS studies, we outline three critical areas of focus for future research in this area. First, this stream of research needs to go beyond adoption and investigate the actual post-adoption use of technology. Second, research needs to focus on the interaction between task and technology. Third, research needs to incorporate behavioral elements such as existing comfort levels for both the physicians and patients. Specific methods which can be used in each area to improve CDSS performance are also suggested.

Keywords: CDSS; pediatrics; decision support tool; CDSS outcomes on healthcare; diabetic care; pediatric CDSS; Computerized Physician Order Entry(CPOE); Least effect of CDSS on healthcare; Diabetes CDSS; Laboratory CDSS.

* Corresponding author: dkansagr@students.kennesaw.edu

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1. Introduction

Computerized CDSSs have seen a tremendous increase in healthcare. The goals of CDSS have been to reduce medication errors, cost, and time; and eventually increase healthcare outcomes by aiding clinicians in their intricate decisions. Broadly, these systems provide alerts, guidelines, orders for specific conditions, show reminders for the vaccination, and help in data analysis with the help of patient records and guidelines [8]. Despite significant advances in CDSS, the meta-analysis of controlled clinical trials shows considerable ambiguity in healthcare quality outcomes, a common phenomenon since the year 2010 meta-study [6,9]. These meta-studies point to reasons such as data interoperability, data quality, system maintenance, or around individuals in terms of their distrust and training [9].

This paper contends that the key reasons for such variance in results does not lie in either the technology or the social aspect. However, it relies on the interrelationship between them. The purpose is to analyze the characteristics of CDSS like technical importance, quality of decision, algorithm used for decision, and outcomes of CDSS. This situation leads to the following research question - What are the factors that leads to the ambiguity in CDSS based outcomes?

2. Method for Analysis

A search was performed on Goggle Scholar using the above-mentioned keywords. Authors came across many papers and articles, but at the end they selected 25 articles with the help of PRISMA framework [7]. The selection criteria include full explanation of CDSS development process and states the results. Authors want to examine CDSSs which has a significant impact and least or no impact on the decision-making process. This paper included articles published between 2007 to 2020. However, for any relevant contents and knowledge about CDSS, authors also analyzed articles before 2007. Then the search narrowed down for papers' content and selected those articles published in English and have access on the full contents.

3. Results

It was found there has been an improvement in the decision-making process. The computerized physician order entry (CPOE) system has reduced the problem of human error in prescription ordering and medication dosing because computer-generated orders are more precise than those written by hand. Out of the total reviewed papers, most of the CDSS proved that CDSS is very helpful in terms of good quality care. Computerized CDSS has improved chronic disease care and guided physicians with proper guidelines. Some of the CDSS show improvement in one factor, but there was no change in another measured factor. The CPOE helps organizations reduce the medication cost and improve patient safety [5]. The guidelines can educate patients about exercise training, education therapy, relaxation therapy,

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and lifestyle change therapy [4]. During encounters, the CDSS takes automatic data from the patient's medical records and assists physicians [1]. Additionally, the CDSS, which uses patient data for recommendations, was unable to provide the desired outcomes [2]. The CDSS within CPOE helps with medication testing and verification of contradiction between drugs, but out of the total conducted studies, four studies do not show any reduction in ADE [11]. There has been huge increase in the number of CDSS applications; however, not all the physicians began to use CDSS.

4. Discussion

The study points three essential research areas for information system (IS) researchers. First, some of the CDSS work very well for the decision-making process, but some do not. Here, there is a lack in the design, methods, algorithms, or techniques that CDSS uses to generate the output. It also suggests a need to understand components of tasks and technology interaction theories such as task-technology fit to eliminate ambiguity in CDSS-based outcomes [3]. Second, Researchers have studied areas where CDSS has been implemented and looked at the outcomes. However, the quality and quantity of usage have not been explored. IS researchers have suggested a multitude of ways in which post-adoptive usage may exist [10]. Furthermore, we argue that not all the providers and organizations are using CDSS while giving care to the patients. We proposed there is a paucity in the training of CDSS. Third, researchers need to examine the behavioral components of the CDSS usage, both from the physician's and the patient's perspective. Some CDSS requires input either from the patients or providers, while giving care to patient providers must keep an eye on guidelines and interaction, so it is hard to enter the details. Because of this ambiguity in CDSS-based outcomes, providers might not have confidence working with CDSS as it lacks reliability and sustainability. Our analysis reveals that CDSS could do more than what it offers now. The CDSS can be expanded with machine learning (ML) and artificial intelligence (AI) to remove ambiguity in outcomes. ML techniques can be helpful to improve the design and the algorithm behind the logic of CDSS which can further help for better performance. However, there is a need for more research on how these advanced technologies will contribute to the development of CDSS.

5. Conclusion

Through the analysis, the investigators concluded that with the growth factor of advanced technology in healthcare, the needs for CDSSs are increasing steadily. The research findings show that if all the organizations and providers start using CDSS, then the quality of care will increase. It is possible to reduce the ambiguity in CDSS-based outcomes with innovation in discussed research areas. Most of the CDSS shows good impact in the healthcare and decision-making process. The findings of CDSS suggest

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it is meaningful to use CDSS while giving care. The study identified three critical areas for further enhancement and improvement of CDSS.

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Generative data augmentation for gastric cancer detection

Sara Nóbrega[a], Diogo Couto[a], António Cunha[a,b,*†]

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real, 5000-801, Portugal*
[b]*INESC TEC – INESC Technology and Science, Porto, 4200-465, Portugal*

Abstract

Gastric Cancer (GC) is the second deadliest type of cancer in the world and an early diagnosis is necessary to drastically increase the survival rate.
Convolutional Neural Networks (CNNs) are Machine Learning models that are highly used to recognize and classify images. However, CNNs are not very used in GC detection because of the lack of images to train networks. In this paper, we propose and evaluate the use of a Generative Adversarial Network (GAN) to produce images to extend the number of samples available to train CNNs. First, a GAN was trained with multiple patches from 274 images representative of GC, aiming to train a generator to be capable of producing GC images. The results archived by the GAN generator are promising since the produced images are similar to the original ones, showing patterns that are present in real GC lesions. When comparing two binary classifiers trained to distinguish normal gastric mucosa from GC, the one trained with images artificially created by the GAN generator, had a better performance.

Keywords: Generative Adversarial Network; Gastric Cancer; Deep Leaning.

1. Introduction

Gastric Cancer (GC) is the second deadliest type of cancer in the world and an early diagnosis is necessary to drastically increase the survival rate. According to [1], Convolutional Neural Networks

* Corresponding author.
E-mail address: acunha@utad.pt.

†

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(CNNs) have enormous success in image recognition and classification. The main issue with using CNNs is that the learning process requires a large number of images.

Since GC tumours are heterogeneous between individuals, it is difficult to create a representative dataset. Besides, the number of Deep Learning (DL) studies related to GC is reduced since it is difficult to find large datasets with annotated medical images [2].

One way to try to overcome this problem is by taking the low amount of images available and use it to train a Generative Adversarial Network (GAN). Using the GAN generator, it is possible to create images based on the original images, augmenting the samples available to developed DL systems.

2. Methodology

Observing Fig. 1, it is possible to distinguish the multiple phases executed during this preliminary study. Firstly, from *Benchmark Dataset for a Digestive Tract Diagnostics Support Systems* [3] were selected representative images of GC and normal gastric mucosa. These raw data images, collected from upper endoscopy videos, suffered some preparation (DP) before being used to train and evaluate the GAN (M_G) and the binary classifiers. Aiming to see the impact of the GAN generated images in the binary classification task, two binary classifiers were trained using the same hyperparameters, varying only in the dataset used: one was trained using the images after the data preparation processes (DSC_1) and the other one was trained using these images and the GAN generate images (DSC_2). After the development of the models, represented in the pipeline as MC_1 and MC_2, both were tested using the same test set.

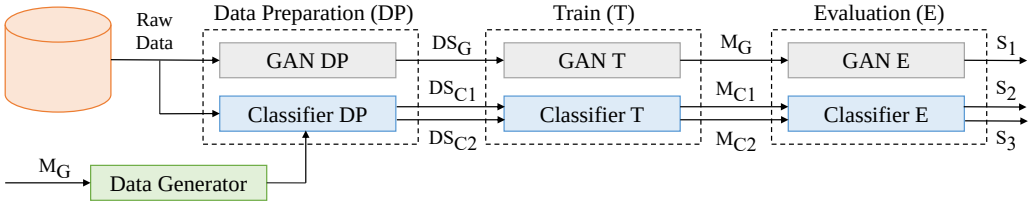

Fig. 1. Pipeline representative of the different phases of the developed work.

3. Results

For each classifier (MC_1 and MC_2) were created ten models using the same hyperparameters and the average performance for both classifiers can be observed in Table 1. MC_1 was the binary classifier

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trained only with the images from *Benchmark Dataset for a Digestive Tract Diagnostics Support Systems* after data preparation and MC_2 was trained using the original and generated GC images.

Table 1. Performance of the binary classifiers developed in this work in the test set.

Metric	MC_1	MC_2	Improvement (%)
AUROC (%)	90,9	93,9	3,0
Accuracy (%)	86,1	89,1	3,0
Precision (%)	83,4	85,5	2,1
Recall (%)	94,0	97,1	3,1
F1 Score (%)	88,4	90,9	2,5

From the twenty models created using the same hyperparameters, were selected the MC_1 and MC_2 models that had a recall in the test set closer to the average of the ten models present in Table 1.

Comparing the performance of MC_1 with the performance of MC_2, the second one classified correctly ten images as normal gastric mucosa, that were wrongly classified by MC_1 as GC. Additionally, MC_2 correctly classified twelve images as GC that MC_1 misclassified (Fig. 2). For last, MC_2 misclassified four normal gastric mucosa images that were correctly classified by MC_1 (Fig. 3). Fig. 2 shows some images that were only correctly classified by MC_2: the first two are representative of normal gastric mucosa and the last two are representative of GC.

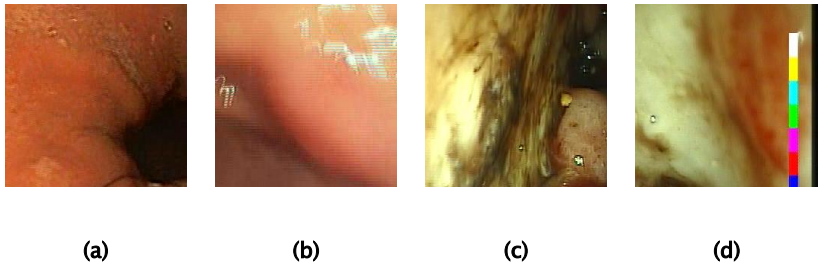

Fig. 2. Example of images that were only correctly classified by MC_2.

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Observing the four images (Fig.3) that were misclassified by MC_2 as GC but correctly classified by MC_1, two of these images have a small tissue area and the other two images have some motion blur associated. This fact could justify the decision of MC_2.

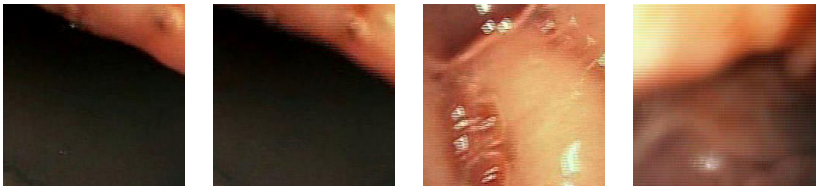

Fig. 3. Example of images that were only wrongly classified by MC_2.

4. Conclusion

The results of this study are promising since it is possible to observe a slight improvement in the performance of the binary classifier trained with the GC images created by the GAN generator. However, it is not possible to conclude that this strategy is viable, since the improvements in the binary classification task are reduced. Hence, further work needs to be made in this area, using a larger and diverse dataset.

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Methods of glaucoma classification focusing on the optic disc

José Camera[b,c], Alexandre Neto[a,c], Cristiana Fernandes[a], António Cunha[a,c]*

[a]*Universidade de Trás-os-Montes e Alto Douro, Vila Real 5000-80, Portugal*
[b]*Universidade Aberta, Lisboa 1250-100, Portugal*
[c]*Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência, Porto 3200-465, Portugal*

Abstract

Glaucoma is one of the leading causes of blindness worldwide. Early detection allows treating patients in time to prevent partial or total loss of vision. However, most diagnoses are late, as there may be the absence of any symptoms, even in a very advanced state. This paper explores deep learning techniques for glaucoma classification. The main objective is to compare the same classification models, trained with full retinal images and only with the optic disc region visible, to see if the results improve and if the models focus on more important regions inside the optic disc. For this work is used public databases of retinal images, namely the RIM-ONE, REFUGE and DRISHTI-GS to train the Inception V3, VGG16 and ResNet 50 models. The results show that the models trained with images, that only have the optic disc visible, had a maximum of 0.92 AUC compared to a maximum of 0.88 AUC for normal images.

Keywords: Glaucoma; Screening; Deep Learning; Convolutional Neural Networks.

* Corresponding author.
E-mail address: acunha@utad.pt.

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1. Introduction

The Deep Learning (DL) classification methods of glaucoma screening lesions in retinal images are a well-established approach. The study of Valverde [1] was selected, for the automatic classification of the VGG19, GoogLeNet (also known as Inception V1), ResNet50 and DENet models. To confirm the performance of VGG19 was applied 10-fold cross-validation (CV). Valverde used 2313 retinal images coming from three different databases: RIM-ONE and DRISHTI-GS (public) and Esperanza (private data set). The best result was obtained with the VGG19 model using transfer learning. The approach of Diaz [2] applied five different ImageNet-trained models (VGG16, VGG19, InceptionV3, ResNet50 and Xception) for glaucoma classification using 10 fold CV strategy to validate the results. To this work was collected five databases: ACRIMA, HRF, DRISHTI-GS, RIM-ONE and Sjchoi86-HRF. The images were cropped around the Optic Disc (OD) using a bounding box of 1.5 times the OD radius. All the models passed the 0.96 of AUC being that an excellent result. The work developed by Norouzifard [3] was used a DL network with transfer learning with the weights of ImageNet. The two DL models used were the VGG19 and the Inception ResNet V2. These two models were pre-trained and then fine-tuned. For this work, two databases were used: one from the University of California Los Angeles (UCLA) and the other, publicly available called high-resolution fundus (HRF). The Inception ResNet V2 model for the UCLA database has obtained a specificity and sensitivity above 0.9 even when re-tested with the HRF database.

2. Methodology

The pipeline used for this work is described in Fig.1. Retinal and mask images from public databases are pre-processed and organised in datasets. These datasets are then used to train the classification models. There will be two types of training: classification models trained with retinal images (DB) and trained with retinal images only with the OD area visible (ground truth mask of the OD is applied to the images, called DBM). The models are tested with the test set, and for a bigger explainability and interpretability, the activation maps are created and analysed.

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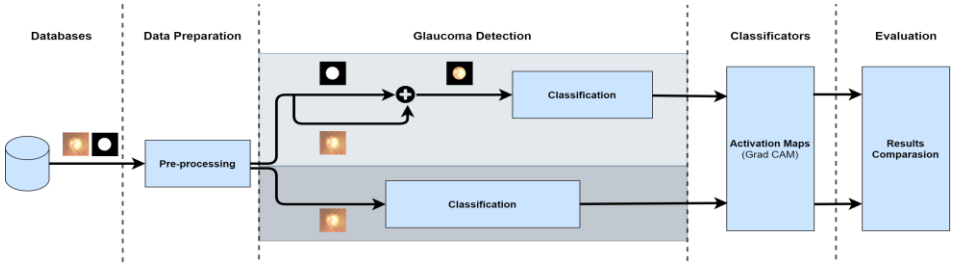

Fig. 1 The pipeline of the work.

3. Results and Discussion

The results of the models trained with DB and DBM are represented in Table 1.

Table 1. Results of classification models from our work for DBM and DB.

	DBM			DB		
Model	**Sen**	**Spe**	**AUC**	**Sen**	**Spe**	**AUC**
Inception V3	**0.82**	**0.79**	**0.92**	0.71	**0.79**	0.88
VGG16	**0.82**	**0.63**	**0.81**	0.75	0.61	0.79
ResNet 50	**0.82**	**0.75**	**0.83**	**0.82**	0.65	0.82

The results from these approaches reach AUCs above 0.8 (except for the VGG16 model trained with DB, with 0.79 of AUC), sensitivity and specificity above 0.7 (only 3 models had specificity below 0.7, which 2 of them are trained with DB). Comparing the two approaches of classification, all the models enhanced the performance when trained only with DBM, increasing, in general, all the metrics. Although the results are very similar, all the models trained with the DBM have superior AUCs than the same models trained with DB. In order to understand and interpret where the model focus to make his decision, the activation maps are created (namely the Grad CAM) and analysed. With the Grad-CAM, can be seen which pixels in the images the models focus on to make their decision (see example Fig.2).

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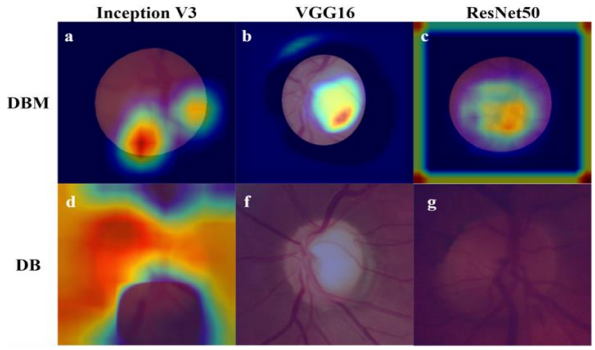

Fig. 2. Grad-CAM for predictions in Inception V3, VGG16 and ResNet50 for the DBM and the DB.

In Fig.2 (a) the model predicted with big confidence that the image is glaucoma and focused within the OD region. In Fig.2 (d), the model predicted that the sample is normal and the Grad-CAM suggests a more sparsed focus from the model. The Inception V3 trained with DBM makes the right prediction unlike the Inception V3 trained with DB. Fig.2 (b) and (c) example models show that using only the restricted area of the OD helps the model to focus and make a decision. Instead in Fig.2 (f) and (g), the image does not show any pixels that activate the model's decision. Despite this, both approaches correctly predict the classification of the image for the VGG16 model, unlike the ResNet50 model that only correctly classifies the image from DBM.

3. Conclusions

The methods described in the literature review use standard classification approaches training models with cropped retinal images in the region of interest focusing on the OD. With this work, is shown that all models selected, trained with images with only the OD visible can achieve better results than the standard approach. To supplement this, the Grad-CAM show more activation and more focus in the models trained with DBM than the models trained with DB. In both approaches the model that showed better results was the Inception V3. Despite this, the improvements are not huge from one technique to the other and can be enhanced even more with the use of more data, to solidify the use of this approach.

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Monitoring and evaluation indicators for tuberculosis based on laboratory routine data managed through REDCap

Vinícius Costa Lima[a,b,*], Filipe Andrade Bernardi[a,b], Jaquelane Silva[c], Marcelo dos Santos[c], Afrânio Lineu Kritski[d], Domingos Alves[e]

[a] *Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil*
[b] *Bioengineering Postgraduate Program, University of São Paulo, São Carlos, Brazil*
[c] *Laboratory of Mycobacteriology, Tropical Medicine Foundation Dr. Heitor Vieira Dourado, Manaus, Brazil*
[d] *Medical School, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil*
[e] *Department of Social Medicine, Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil*

Abstract

In Brazil, tuberculosis is a disease of high incidence that requires strict surveillance. Indicators are valuable tools for health management, evaluation and vigilance, but they are laborious to calculate. This work seeks to automate the computation of mandatory indicators for tuberculosis in Brazil from laboratory routine data collected and managed through REDCap, focusing on performance indicators for TB laboratories. An easy-to-use web-based tool is presented to allow the production of TB indicators based on pre-defined calculation formulas, reducing the workload of a costly and repetitive task.

Keywords: health indicators; REDCap; tuberculosis; digital health.

* Corresponding author.
E-mail address: viniciuslima@usp.br

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1. Introduction

Tuberculosis (TB) is an infectious disease that is among the top 10 causes of death in the world. Brazil is part of the top 30 high TB burden countries, with an estimate of 96.000 cases in 2019 [1].

Indicators are valuable tools for health management, evaluation and surveillance. The availability of a set of indicators tends to facilitate the monitoring of health goals and, together, they make up the epidemiological profile of the disease in a given region. These are measures that have relevant information about attributes, dimensions and the performance of the health system. The selection of the basic set of indicators should be adjusted to the availability of information systems, data sources, resources, priorities and specific needs in a given region [2,3].

Indicators for monitoring the control and impact of tuberculosis reflect the performance of health services in the quality of care for patients. In Brazil, in general, they are related to the detection, diagnosis, TB-HIV co-infection and the outcome of tuberculosis cases [4]. Also, indicators are used to assess the quality of laboratory processes related to TB in six general areas, such as culture positivity rates, contamination rates, smear status rates, turn-around times, drug resistance rates and proficiency test performance. The indicators are defined in several official documents, such as, for example, in the Manual of Recommendations for the Control of Tuberculosis in Brazil [5], and in other operational manuals, depending on the objectives of a specific set of indicators.

This work seeks to automate the computation of mandatory indicators for tuberculosis in Brazil from laboratory routine data collected and managed through REDCap, focusing on performance indicators for TB laboratories.

In the next section, the methodology and the web-based tool developed for TB indicators calculation is presented. Then, in the last section, final considerations are drawn.

2. Calculating indicators for tuberculosis

This work uses Action Research and a socio-technical approach for practical problem-solving and to expand scientific knowledge and competencies of researchers [6].

The Research Electronic Data Capture (REDCap) is a metadata-driven application for data collection and management in clinical research and operational support [7].

In a laboratory of mycobacteriology located in Manaus, Brazil, routine data is daily collected through REDCap. Mainly, data include sample tracking and tests results, such as smear, culture, antimicrobial susceptibility and the rapid molecular test for tuberculosis. Due to the large volume of data, manually calculating mandatory periodic indicators is time consuming and prone to errors.

Therefore, a web-based tool was developed, as shown in Figure 1. The user only has to select the dataset and the desired time frame. Based on the pre-defined formulas, the system extracts only the

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necessary data from REDCap and presents the calculated indicators in a table. The user can export or print the results.

Figure 1. Web-based tool for calculation of TB indicators in Brazil.

Each indicator and their formulas are stored in a relational database, which can be managed through a backoffice admin system. The system demands a specific format for the formulas, so the variables can be replaced with appropriate values extracted from the REDCap database using its the Application Programming Interface (API). Manuals are available to guide users on how to create new indicators and define their respective formulas.

3. Final considerations

This work presented an approach to facilitate the computation of mandatory health indicators for tuberculosis in Brazil using routine laboratory data collected and managed through REDCap. The main goal is to address performance indicators that help assess the quality of laboratorial processes related to TB.The developed tool relies on real data to deliver a user-friendly tool adaptable for any calculation formula. It allows to reduce the time spent on a costly and repetitive task.

The tool can be easily managed and new databases (projects) from REDCap can be included through the backoffice system. As future work, it is intended to extend the system to allow the use of additional structured datasets from sources other than REDCap.

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Unsupervised machine learning techniques in the analysis of bad outcomes in the treatment of tuberculosis: a research protocol

Ana Clara de Andrade Mioto[a]*, Newton Shydeo Brandão Miyoshi[b], Filipe Andrade Bernardi[a], Victor Cassão[b], Domingos Alves[c]

[a]Bioengineering Postgraduate Program,University of São Paulo, 400 Trab. São Carlense Avenue, 13566590, São Carlos/SP, Brazil
[b]Barão de Mauá University Center, 423 Ramos de Azevedo Street, 14090180, Ribeirão Preto/SP, Brazil
[c]Ribeirão Preto Medical School, University of São Paulo, 3900 Bandeirantes Avenue, 14049900, Ribeirão Preto/SP, Brazil

Abstract

Worldwide, tuberculosis is still the most fatal disease, in one year there were around 1.4 million deaths. Just Brazil is responsible for more than 0.9% of the cases registered in the world, and still is a country with high levels of inequality. The World Health Organization has set goals to reduce these numbers and increase socioeconomic equity. As a result, several initiatives aimed at research and innovation emerged, bringing new approaches and methods that can be applied to tuberculosis data and reduce the number of deaths. This protocol will serve as a guideline for the project, which will analyze the undesirable outcomes in the treatment of tuberculosis. Knowledge Discovery in Databases and Unsupervised Machine Learning algorithms will be applied, such as clustering. Therefore, it will be possible to have more efficient treatments and control measures, directed to the discovered patients profiles.

* Corresponding author. Tel.: +55-16992359934.
E-mail address: anaclara.mioto@usp.br

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Keywords: Tuberculosis; Machine Learning; Unsupervised Analysis; Decision-Making Support.

1. Introduction

One of the most fatal infectious diseases worldwide remains tuberculosis (TB). Despite it being a curable disease, caused by Mycobacterium tuberculosis complex [1], in a year 1.4 million people died and about 10 million people sickens [2]. Along with other comorbidities such as HIV, TB becomes even more lethal. In 2019, TB contributed to more than 208.000 deaths among HIV people [2].

Furthermore, another important factor associated with this disease are socioeconomic and cultural issues. WHO and several authors have already established a relation between poverty, which can be the result of poor health conditions, and TB, which can generate poverty by restricting subsistence and employment possibilities [1]. In countries with greater social inequality and lower per capita income, the high numbers of cases stand out, also showing this relation globally [2].

Brazil is among the 30 countries with the highest prevalence of TB, only in 2019 presented about 96.000 cases, being 11.000 cases with HIV-positive [2], and several studies are conducted, analyzing how socioeconomic conditions, interventions targeted in this direction and the possible outcomes of TB are related [3]. These can allow a better understanding of the situation in Brazil, leading to better decision-making regarding actions that need to be implemented, towards the control of TB and the goals established by WHO.

There are many computational techniques that could be applied to analyze healthcare data. Particularly, in the Machine Learning (ML) approach there are Unsupervised Learning algorithms. The aim of this approach is to identify unknown (or latent) aspects in the dataset of interest. This process is performed in an automated way by ML algorithms such as K-Means. Often these unknown patterns are non-linear combinations of different pieces of information.

Therefore, the aim of this protocol is to guide in the discovery of unknown patterns that can associate sociodemographic and clinical factors with different patient outcomes, in particular, the abandonment, death and resistance. This will be done through Data Mining and Machine Learning techniques applied to tuberculosis treatment data, originating from all over the state of São Paulo.

2. Methodology

This is a protocol of an evaluative research, with a descriptive design and a quantitative and qualitative approach. So, the action research methodology will be followed. To ensure best practices throughout the development of model applications, the free software model will be adopted, reducing royalties in software licenses payment and increasing the digital inclusion process and organizations' encouragement.

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The Research Process is separated into stages, methods and tools presented in this article and was designed to guide its understanding and development. Is important for establishing correlation between them, since we know that each domain can be applied in different steps, for example, Python programming language will be used in all domains that belong to the Research and Development stage.

Now describing the stages, in the first step is proposed a literature review on unsupervised machine learning methods for tuberculosis applied to monitoring, diagnosis and outcome predictions, a method based on Instituto Joanna Briggs (JBI) guideline will be followed [4]. As recommended by the (JBI), a three-step search strategy will be followed in published and unpublished studies. In this review, we seek to answer the question: "What is the minimum approach and techniques used in tuberculosis prediction models?". The search will be performed following an analysis of the words contained in the title, abstract and the index terms available at MeSH (Medical Subject Headings), a vocabulary thesaurus used for indexing articles for PubMed, intending to compare and propose suggestions for the Science project in the TB bad outcomes context.

In the second step, from the reference materials and practices carried out to understand the techniques, acquired in the previous step, will be able to apply all Knowledge Discovery in Databases (KDD) process in the Brazilian data, that is a process of identifying patterns that are valid, unknown, possibly useful and understandable, present in a dataset [5]. In this work a dataset with more than 200.000 records, collected between 2006 and 2020 through the TBWEB system. TBWEB is an epidemiological surveillance and real-time monitoring system in the state of São Paulo.

The KDD can be divided into the following steps: problem definition, being important to delineate the objectives of the application; data selection, where we define the target dataset; data preparation or preprocessing is the step that consumes most of the time in a project, consisting of cleaning, feature selection, and in some cases data transformations; data mining, containing sub steps for the application of algorithms and development of a machine learning model; interpretation of results; evaluation, and finally the use of knowledge discovered [6].

In data mining step, the ML techniques will be applied, more specifically, a clustering technique. Before creating the model, it will be necessary to have defined the main attributes to be used as parameters for the clustering process, to be able to choose which algorithm will be used. Two important algorithms are K-means and Fuzzy C-means, for example.

The third stage is a qualitative analysis and validation of the developed model. Here, it will be possible to have a better understanding of the data's behavior, seeking to identify patterns and factors present in the clusters, which will lead to the expected results for the benefit to control TB, in the Brazilian scenario.

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3. Expected Results

This study is one of the examples that were designed to achieve the goals defined by the End TB Strategy of the World Health Organization (WHO) [2]. As one of the desired results, we intend to guarantee, with the steps of understanding and preparing the data, that this dataset can serve as a basis for future analysis and increase the availability of information, which can help the decision-making by professionals working in the area. It is also expected to identify success factors in fighting the TB, from the analysis of possible hidden patterns associated with negative outcomes, besides the identification of patient profiles, with social-cultural categorization, which will help the planning of more effective actions and locate with more precision patients with latent tuberculosis. About the unsupervised machine learning, is expected to obtain predictors of bad outcomes according to patient profiles, with good accuracy, which will lead to better diagnoses and more effective treatments. For future work, we intend to put this protocol into practice.

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