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The mission of the IJISPM - International Journal of Information Systems and Project Management - is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

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Editorial

The mission of the *IJISPM - International Journal of Information Systems and Project Management* is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

It is our great pleasure to bring you the first number of the fourth volume of IJISPM. In this issue readers will find important contributions on management of information systems standards, management of lessons learned, adoption of decision support systems, and management of project interdependencies in project portfolios.

The first article, “Developing and enforcing internal information systems standards: InduMaker’s Standards Management Process”, is authored by Claudia Loebbecke and Bernhard Thomas. It is widely agreed that standards provide numerous benefits when available and enforced. Company-internal Information Systems (IS) management procedures and solutions, in the following coined IS ‘standards’, allow for harmonizing operations between company units, locations and even different service providers. However, many companies lack an organized process for defining and managing internal IS standards, which causes uncertainties and delays in decision making, planning, and design processes. In the case study of the globally operating InduMaker (anonymized company name), an established manufacturing supplier, the authors look into the company-internal management of IS standards. Theoretically grounded in the organizational and IS-focused literature on business process modelling and business process commoditization, they describe and investigate InduMaker’s newly developed Standard Management Process (SMP) for defining and managing company-internal business and IS standards, with which the multinational pursues offering clear answers to business and IT departments about existing IS standards, their degree of obligation, applicability, and scope at any time.

As Marcirio Chaves, Cíntia Araújo, Laura Teixeira, Debora Rosa, Irapuan Júnior and Cláudia Nogueira, state in the second article “A new approach to managing Lessons Learned in PMBoK process groups: the Ballistic 2.0 Model”, in any organization, dealing with lessons learned is a complex issue that involves people, processes and technologies. Although lessons learned processes are already well established in the project management community, the use of modern web technologies to support them is still in its infancy. This paper introduces a new model to manage lessons learned in PMBoK process groups. The model draws upon interdisciplinary literature, which embeds lessons learned processes, shared context and Web 2.0 service models. It is supported by Web 2.0 technologies and centered in PMBoK process groups to allow a thorough overview of the project. An exploratory focus group was set up to validate the model qualitatively. The adoption of this model can help academics and practitioners using PMBoK process groups to acquire a better understanding of managing lessons learned in projects.

In the third article, “Adoption of web-based group decision support systems: experiences from the field and future developments”, Jos van Hillegersberg and Sebastiaan Koenen state that, while organizations have massively adopted enterprise information systems to support business processes, business meetings in which key decisions are made about products, services and processes, are usually held without much support of information systems. This is remarkable as group decision support systems (GDSS) seems to be suitable for this purpose. They have existed for decades and modern versions benefit of web-based technologies, enabling low cost any-place, any time and device independent meeting support. In this article, an exploratory case research, the authors study nine organizations in four different adoption categories to learn more about the reasons for the relatively slow adoption of web-based GDSS. Using the Fit-Viability adoption framework, they conduct interviews with the organizations that have experience using GDSS, concluding that adopting GDSS requires considerable and carefully planned change of processes that are deeply grounded in the organization.

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Sameer Bathallath, Åsa Smedberg and Harald Kjellin, in their article "Managing project interdependencies in IT/IS project portfolios: a review of managerial issues", claim that adequately managing project interdependencies among diverse and simultaneous projects is deemed critical for successful implementation of project portfolios. The challenge is significant because it may entail managing a complex network of project interdependencies that keeps changing over time. This article investigates the managerial challenges that may undermine effective management of project interdependencies in IT/IS project portfolios. The investigation is based on evidence from reviewing relevant literature and documented studies associated with managing project interdependencies. The main contribution of this study is to discuss three managerial challenges of project interdependencies in project portfolios. The authors discuss the challenges from three perspectives: types of interdependencies; patterns of interaction in interdependencies; and cost/benefit impact of project interdependencies.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work, for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

João Varajão

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João Varajão is currently professor of information systems and project management at the *University of Minho*. He is also a researcher of the *Centro Algoritmi* at the *University of Minho*. Born and raised in Portugal, he attended the *University of Minho*, earning his Undergraduate (1995), Masters (1997) and Doctorate (2003) degrees in Technologies and Information Systems. In 2012, he received his Habilitation degree from the *University of Trás-os-Montes e Alto Douro*. His current main research interests are in Information Systems Management and Information Systems Project Management. Before joining academia, he worked as an IT/IS consultant, project manager, information systems analyst and software developer, for private companies and public institutions. He has supervised more than 50 Masters and Doctoral dissertations in the Information Systems field. He has published over 250 works, including refereed publications, authored books, edited books, as well as book chapters and communications at international conferences. He serves as editor-in-chief, associate editor and member of the editorial board for international journals and has served in numerous committees of international conferences and workshops. He is co-founder of CENTERIS – Conference on ENTERprise Information Systems and of ProjMAN – International Conference on Project MANagement.

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Developing and enforcing internal information systems standards: InduMaker's Standards Management Process

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Abstract:
It is widely agreed that standards provide numerous benefits when available and enforced. Company-internal Information Systems (IS) management procedures and solutions, in the following coined IS 'standards', allow for harmonizing operations between company units, locations and even different service providers. However, many companies lack an organized process for defining and managing internal IS standards, which causes uncertainties and delays in decision making, planning, and design processes. In this case study of the globally operating InduMaker (anonymized company name), an established manufacturing supplier, we look into the company-internal management of IS standards. Theoretically grounded in the organizational and IS-focused literature on business process modelling and business process commoditization, we describe and investigate InduMaker's newly developed Standard Management Process (SMP) for defining and managing company-internal business and IS standards, with which the multinational pursues offering clear answers to business and IT departments about existing IS standards, their degree of obligation, applicability, and scope at any time.

Keywords:
information systems; standards process; standards management; project management; practice case.

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1. Introduction and problem statement

It is widely agreed that Information Systems (IS) management procedures and solutions, in the following coined IS 'standards', provide numerous benefits when available and enforced [1, 2, 3]. They can be helpful in different areas within of IS and IT. A multinational's internal IS Standards[1] allow following up on strategic goals such as cost/quality optimization, agility, or flexibility. They provide the basis for quality comparison regarding the effectiveness and efficiency of operations and the cost-efficiency and speed of delivery, and they allow for harmonizing operations between company units, locations and even different service providers [9]. Ultimately, internal standards are the means for industrializing operations – both in IT and in business processes [e.g., 10, 11].

However, the active management of company-internal IS standards is still often an open issue. Managers typically hear questions about a specific standard in use such as: 'What is our standard in so and so? Why did we use standard *abc* in plant A, but then standard *xyz* in region B for the same purpose?' They find it challenging to compare their IS with what other companies are using, especially as often it is not clear how to benchmark their IT services in some process as they do not know what to compare and on what basis. Purchase managers across the globe wonder whether they can join strategies in purchasing equipment, services or licenses for *xyz*. Project managers on site have to quickly integrate a new acquisition or new plant into existing IT services. Overall, persons in charge in Information Technology (IT) departments and in management typically agree that they need a regulation on deployment of *xyz* throughout the company. All these issues arise in the absence of clearly defined and documented company-internal IS standards. Apparently, companies lack an organized process for defining and managing those standards. Missing such process generates uncertainties and delays in decision, planning, and design processes; employees – especially in IT – often express a gut feeling that their company is using a particular standard, but they cannot tell how or why.

Here this explorative case study delves deeper: Theoretically grounded in the organizational and IS-focussed literature on business process modelling [7, 12, 13] and business process commoditization [1, 10, 14, 15], we aim at describing and investigating a multinational's newly developed organized Standard Management Process (SMP) for defining and managing company-internal business and IS standards. It takes the case of globally operating InduMaker AG (InduMaker), an established, globally operating manufacturing supplier, and investigates how the company handles internal management procedures, standards – especially IS standards. How do standards within InduMaker come to life? Which standards get rolled-out globally? Who manages the disposal of a standard when a 'better way' seemed to have popped up somewhere around the world? In other words, how is a Life-Cycle approach applied to standards? To tackle these questions, we describe and investigate InduMaker's global company-wide *Standard Management Process (SMP),* which is applicable to all InduMaker and its majority holdings as well as minority holdings under the multinational's management control. InduMaker's idea is to prescribe a company-wide clear and comprehensive routine procedure to request, define, approve, document and implement IT standards in a wide range of topics. The company's main objective for the effort to develop an organized process for defining and managing IS standards is to offer clear answers to business and IT about existing standards, their degree of obligation, applicability, and scope at any time. As so often, the devil is in the details – especially when it comes to a global, but standardized implementation and roll-out of IS management procedures.

The next sections outline the research approach and provide a short, anonymized company brief. Section 4 synthezises the value of IS standards from the case company's perspective. This sets the ground for section 5 and 6, which offer a detailed description and analysis of InduMaker's Standard Managent Process. Finally, section 7 presents Key

[1] In this paper, we use InduMaker's internally used term IS standard when referring to standardized IS management procedures. Hence, InduMaker's Standard Manangement Process (SMP), at the core of this study, refers to managing IS related rules and decisions in a standardized way through the globally active multinational. This definition is different from [4, 5, 6, 7, 8] who use the term IS standards for technical standards defined as an agreed-upon specification for a way of communicating or performing actions.

Performance Indicators (KPIs) along InduMaker's SMP. Section 8 provides an assessment of InduMaker's Standard Management Process, before section 9 concludes with some lessons learned, implications and limitations.

2. Research approach

This case study on globally standardizing business processes and procedures in the wide context of IS aims at meeting the research criteria of relevance, applicability, and specificity as proposed by Cheng and McKinley [16] in their work on integrating organization research and practice.

To illustrate, investigate, and assess InduMaker's *Standard Management Process (SMP)*, we conduct a single exploratory case study [17, 18, 19]. The study should allow us reflecting the practice reality of designing and diffusing a Standard Management Process (SMP) throughout a truly global company operating in more than 49 countries. With only limited quantitative data available, a single case study seems to be best suitable for an in-depth analysis of qualitative data focusing on the 'how' [19, 20].

We gathered mostly qualitative data from three major organizational sources:

- Firstly, between March 2012 and August 2013, we conducted seven informal, face-to-face in-depth interviews with top management, including IT management and further interviews with project managers via mail and telephone. We also used opportunities for statements and feedback from invited managers provided by a closed intranet discussion forum which held the SMP concept for reference. The choice of informal interview and feedback settings encouraged respondents to talk about their perceptions and impressions of InduMaker's future Standard Management Process and follow up on it in its various development stages. The informal style gave respondents the opportunity to speak out frankly without restrictions to specific issues. Interviewees could thereby more adequately reflect the proceedings of the project and emphasize points of perceived importance. Any vagueness resulting from the initial interviews was checked with the respective interviewee if available or with senior managers involved. Compared to objectified experimental or survey methods, the applied research method implies a certain subjectivity;
- Secondly, we evaluated four workshops, each with a group of 7 to 13 company managers from different company locations and external consultants;
- Thirdly, we complemented our data by evaluating an extensive set of internal documents. We had the opportunity to analyze numerous qualitative meeting minutes and project reports and we could look into internal repositories of data related to or resulting from the overall project related activities.

At the end, InduMaker's Chief Technology Officer (CTO) and several other InduMaker's officials reviewed the case paper to exclude factual errors.

3. InduMaker AG: company brief

InduMaker – a globally operating industry supplier – ranks among the top ten in its industry segment worldwide. With more than 150,000 employees at almost 200 locations, in 2014 the company achieved preliminary sales of approximately USD 48 billion. As a large multinational, InduMaker operates in global, competitive markets where IT services have been the backbone for most distributed business processes. Many of its IT services across business sectors and countries have reached commodity status, suggesting that the according standards are carefully managed. For instance, following a merger at the beginning of the millennium, InduMaker integrated thousands of users into one e-mail system as employees from the acquired company were familiar with Outlook Exchange whereas InduMaker had been using Lotus Notes Domino.

4. Value of IS standards – InduMaker’s perspective

To InduMaker, a multinational with some 190 sites spread all over the world, the value of applying company-wide IS standards lies in cost, time to market (of IT services), operational efficiency and user satisfaction [see also 10, 21, 22]:

- Costs: Standardized IT products (hardware, software) and IS operations reduce coordination costs, allow for economies of scale in purchasing, and significantly reduce IT service cost. Running homogeneous IT environments and workplace computing allows for controlled centralization of resources and thus making effective use of internal and external IT providers’ skill sets [23];
- Time to market: IS standards allow for accelerated setting up and provisioning a new of IT Service or of provisioning of homogenous services in the course of integration of new M&As [24];
- Operational efficiency: As standards apply to operating and managing IS operational resources – servers, storage, networks, distributed devices – 24x7 can be established on the same staff count in a follow-the-sun mode. A common end-to-end monitoring standard supports steady availability and performance [1, 3];
- User satisfaction: User Support can reach much deeper on a per case basis based on known standards as the knowledge base (documented and in support staff) is likely to be more comprehensive [25, 26].

On the other hand, InduMaker also faces the downside of enforcing adherence to centralized IS standards – especially the dependence on manufacturers, their strategies, and their economic well-being.

5. InduMaker’s Standard Management Process (SMP): Overview

For many years, there has been agreement across InduMaker that standards help promoting sustainability as they allow for transferring problem solving and best practice across the company. Hence InduMaker aims at applying standards to all processes – in business and IT. Within IT, InduMaker sees standards – and their management – as essential and efficient for designing IT solutions in reply to business demands, for passing project and quality gates, for inter-company comparisons, and for fast integration following M&As.

In summary, InduMaker’s SMP says that everybody within InduMaker can request a new standard or a change or disposal of an existing one. A request can be submitted formally or informally. For each requested standard, a *Standards Committee* nominates the *Standards Approval Authority* in accordance to the respective scope and object and the level of obligation. The *Standards Committee* evaluates the requested standard with respect to its future strategic and technological positioning and the possibility to fulfil its purpose. Once a standard is approved by the *Standards Approval Authority*, it must be documented and published, and later reviewed on a regular, defined basis. In any case, the requester will receive feedback about the status of the request in due time.

5.1 SMP-Terminology: Standards – and their Objects, Areas of use, and Types

As a first step, InduMaker promotes a company-wide terminology with respect to standards. With defining a ‘standard’ and using harmonized terms InduMaker aims at establishing clarity in communication, avoiding misunderstanding, and decreasing the risk of misinterpretation.

Standardization – within InduMaker – describes the process of defining and implementing a standard. A *standard* is an agreed and approved system of principles and rules for common and repeated use to serve a specific purpose. It is unambiguous, interchangeable, and compatible with its environment, as well as documented and published. With regards to a standard, InduMaker distinguishes (1) object (class), (2) area of use, and (3) type.

Objects come in different categories. Typically they are categorized into aspects of ‘What’, ‘How’, and ‘By what means’. Table 1 shows the list of objects considered by InduMaker.

Table 1. Standard Objects

Objects		
Client SW	Service	Design
Location IT Setup	Architecture	Specification
Technology	Security	Data Model
Product	Process	Format
Sourcing	Workflow	Documentation
Operations Practice	Method	Role

The *Area of Use* relates to the area of Business or IT in InduMaker's enterprise specific ontology (see Table 2 for InduMaker's Areas of Use in Infrastructure Services). Obviously, the list of use areas gets adapted according to any changes in InduMaker's corporate IT[2].

Table 2. Areas of use – Infrastructure Services

Areas of Use – Infrastructure Services		
Managed DB	MAN	Resource Directory
Managed Server	DHCP / DNS	Patch Management
Managed User Workstation	Remote Access	Virus Protection
Managed PDA	Secure External Access	Messaging Operations
Managed PBX	Internet Guest Access	Online Collaboration
WAN	Internet Access Gateway	Real-Time Collaboration
WAN Acceleration	Internet Mail Gateway	Asset Management
LAN	Terminal Service	Monitoring
WLAN	Data Center Facility	Service Desk
RADIUS		

Finally, the standard *Type* determines the level of obligation that the standard implies. It depends on a particular Level of Obligation. InduMaker distinguishes three types of standards: (1) recommendations; (2) specifications; and (3) regulations (see Fig. 1).

[2] Originally, the SMP and its terms and definitions are generic with respect to the field of application within InduMaker. The SMP could be deployed in any area of business, business process or supporting function, like purchasing, finance, HR. However, to start with, the application of the SMP has been restricted to the field of Business IT and, for the learning curve initially, IT Infrastructure.

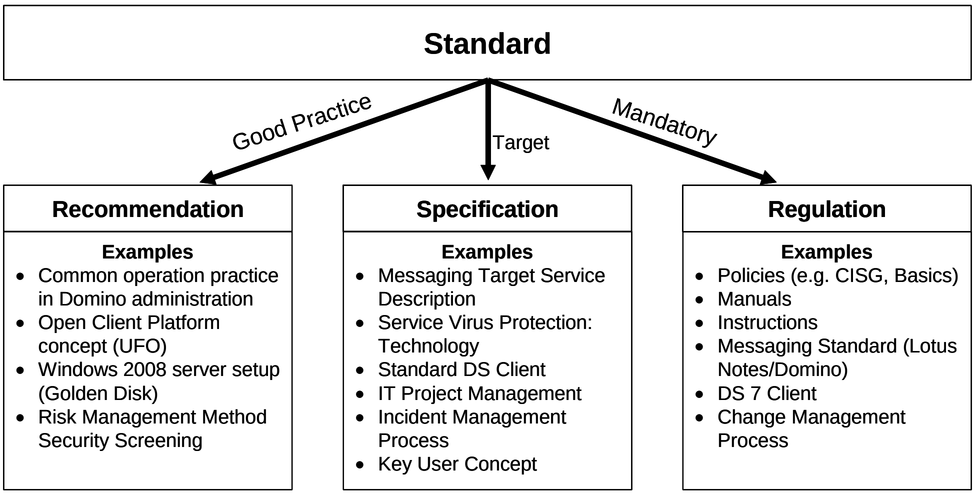

Fig. 1. InduMaker's Standard Types

A *Recommendation* relates to a well-proven method or technique to solve a specific IT question. Practice is based on the long-term experiences that are proven over time to fulfil a certain demand by many people. The Level of Obligation is 'Could/Good Practice'. A Specification sets out detailed requirements that are expected to fulfil a certain demand. It describes what should be done/used, how something should be done, and which criteria are expected. It also describes the procedures for checking conformity to these requirements. The Level of Obligation is 'Should/Target'. Regulation provides binding legislative rules. Documents types include policies, manuals, and instructions. A regulation can also be a technical specification, code of practice, or a technical guidance that outlines some means of compliance. The Level of Obligation is 'Shall/Mandatory'.

5.2 Roles and responsibilities in InduMaker's SMP

InduMaker's SMP builds on clearly defined roles throughout its six phases (see below). The roles involved in the SMP include *Standards Committee, Standards Approval Authority, Standards Owner, Experts Group, Standards Requester, Stakeholder, Process Owner*[3]*, and Process Manager*.

- Anyone within InduMaker can act as a *Standard Requester* and issue a request for standardization or propose a specific standard for approval;
- The *Standards Committee* is a central, or, at least, a virtually central team that is accountable for managing standards requests (acceptance, register, prioritization, providing an overview, and status of the existing and retired standards as well as of rejected standard requests). It is accountable for the nomination of the respective Standards Approval Authority and for arranging and nominating the experts group. The Standards Committee has to consider that authorities from all areas are represented so that Standards Approval Authority and Experts Group are able to fulfill their tasks. Finally, the Standards Committee holds the Key Performance Indicators (KPI) reports;
- The *Standard Approval Authority* is designed in accordance with the Change Management Process; their staffing varies dependent on obligation, standard type, area of use and scope. The authority is responsible for the drafting of a standard and its final approval. It issues the note of acceptance/rejection, approval/disapproval when appropriate and nominates the Standard Owner;

[3] Defined and required by ITIL, the IT Infrastructure Library (www.axelos.com/itil).

- The *Standard Owner* reviews the standard with regard to the scope, to the decision, to the level of obligation and to the applicability of the standard. This may be based on feedback, e.g. from the stakeholders or KPI evaluation. He is accountable that the standard documentation is available, complete, and compliant to the standards documentation template. He organizes the publication and collection of acknowledge receipts of the IT management. The Standard Owner is also responsible for regular reviews of the standard and its documentation and drives its evaluations. Thereby, he ensures that the KPIs are implemented and reported as defined to evaluate the standard effectiveness and efficiency. He provides information to the Standards Approval Authority, the Experts Group, and to the Process Owner for improving process quality, and oversees that the IT organizations across InduMaker are aware of the standard and have the necessary support to apply the standard as designed (training material, awareness campaigns). He receives feedback from the stakeholders and manages the evaluation of the standard with respect to its future strategic and technological positioning;
- The *Experts Group* is responsible for validating the request and the feasibility of the requested standard. It makes sure that the requested standard is aligned with corporate policy, IT Strategy and IT Architecture. It has to identify the benefits for the standard and estimate the efforts for drafting it. Further, it is the Experts Group that designs and drafts a requested standard. It is in charge of requested standard documentation and a proposal for the standard rollout/implementation. The Experts Group consults with the IT Organization (stakeholder) to apply the standard and with the Standards Owner to evaluate it with respect to its future strategic and technological positioning. Finally, the groups is responsible for planning the disposal of an existing one;
- A *Stakeholder* is the person who has contact with a standard, e.g. the respective IT Organization, the Service Owner who have to implement a standard, the IT management and IT employees who have to use a specific regulation, wording, process, the process owners and process manager.

Finally, in line with the IT Infrastructure Library (ITIL), each standard request has a *Process Owner* and *Process Manager*, ideally one each per division:

- The *Process Owner* is accountable for the overall quality of the process and oversees the management of, and organizational compliance to, the process flows, procedures, data models, policies and technologies associated with the IT process. His responsibilities include the design, change management, and continuous improvement of the process and its metrics. In charge of for the process design, he documents and publishes the process and incorporates the relevant policy and standards into the process. He oversees the definition and review of the KPIs to evaluate the effectiveness and efficiency of the process. The process owner is responsible that all process managers are aware of their role in the process and have the required training. Further, he ensures that the process, roles, responsibilities and documentation are regularly reviewed and audited;
- The *Process Manager* is accountable for planning and coordinating all process management activities in his IT area. He is responsible for the quality of process realization based on KPIs and the reporting of process as well as the daily operation of his process. He cares that the defined procedure are followed. He controls the planning and coordination of the process management and the adherence to prescribed procedure. Analyzing the results of the KPI reporting, he ensures that corrective measures are taken. He answers process-related questions from the process performers, validates change requests from the process performers, and passes the qualified specification on to the process owner.

6. InduMaker’s Standard Management Process (SMP): Phases

InduMaker has opted for a phased, lifecycle-type process that manages standards and thus drives standardization where reasonable from proposal to implementation including review and, if outdated, disposal/renewal of standards. The deliverables of each phase constitute milestones to be accomplished before entering the next phase. Those milestones at the end of each phase help maintaining overview and transparency about any standard throughout its life-cycle and throughout InduMaker. Fig. 2 depicts the six phases of InduMaker’s newly designed SMP.

	Request for Standard	Evaluation & Planning	Drafting & Approval	Implementation & Establishmt.	Operation & Maintenance	Replacement & Disposal
Input	• Request for a new standard • Request for rework of an existing one	• Detailed request	• Request for a new standard • Request for rework of an existing one	• Standards document • Implementation approach	• Standards document	• Standards documentation • Assessment results • IT strategy or IT architecture change
Acti-vity	• Detailing and registration of standards request • Acceptance • Nomination of the experts group and the approval authority (new)	• Evaluation of the standards opportunities, risks and benefits • Check alignment with IT strategy & IT architecture • Estimation of efforts	• Proposal for the standard, incl. implementation approach • Nomination of the standards owner • Approval / disapproval of standards	• Standard publication • Implementation • Enabling the supporting IT organizations (info guide, trainings	• Assessment if the standard is fulfilled and applied • Review of standard for need of revision	• Periodically review assessment results • Decision about further approach towards the standard
Out-put	• Detailed request • Acceptance note • Updated standard list (request) • Feedback to the requester	• Description of request, incl. estimated effort, resources, budget, etc. • Feasibility and risk assessment • Go ahead decision note	• Standards document based on template • Implementation approach • Approval note • Nominated / confirmed standard owner	• Published standard • Updated standard list • Implementation report • Acknowledgement note	• Assessment results • KPI reports • Optimization suggestions	• Review report • Decision note • Updated standard list (disposal) • Request for rework of a standard
Who	Decision: • Standards committee	Decision: • Standards committee	Execution: • Expert team decision • Approval authority (as part of standards committee)	Execution: • Service owner • Councils • Stakeholder	Execution: • Service owner • Councils • Stakeholder	Execution & decision: • Standards owner

Fig. 2. InduMaker's SMP – Overview of phases

6.1 Phase 1: Request for Standard (RfStd)

The purpose of this phase is to log the request concerning a new or existing standard or for disposal of an existing standard. The Standards Committee defines the Standards Approval Authority according to scope, object and level of obligation and it nominates a group of experts to whom it hands over the initiation of the standardization procedure. Minimum deliverables are a detailed description of the Standard Request (for abbreviated examples see Appendix 1a-c), an acceptance note, the identification and information of the respective Standards Approval Authority and the Experts Group and as well as an updated standard list where appropriate. Fig. 3 depicts the different steps of Phase 1.

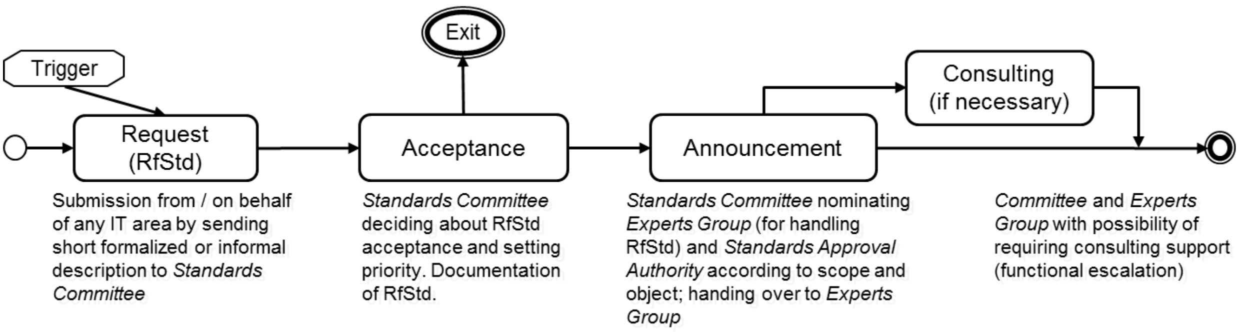

Fig. 3. SMP Phase 1 – Request for Standard

6.2 Phase 2: Evaluation & Planning

The purpose of the Evaluation & Planning phase is to firstly identify and validate opportunities arising from the requested standard and to point to dependencies with already existing solutions. This implies evaluating implementation benefits and costs and to align the proposed approach with the defined IT Strategy & Architecture in order to ensure standard feasibility in the respective area. This phase includes further planning of the time, effort, resources, budget for the development and implementation of the proposed standard. According to those steps, the minimum deliverables of Phase 2 are a request description, the standard object, type, level of obligation, and scope, the prospective benefits including constraints and dependencies, a feasibility and risk assessment, and finally a 'Go Ahead' note for processing the request. The Requestor will be informed about the decision. Fig. 4 show the different steps of Phase 2.

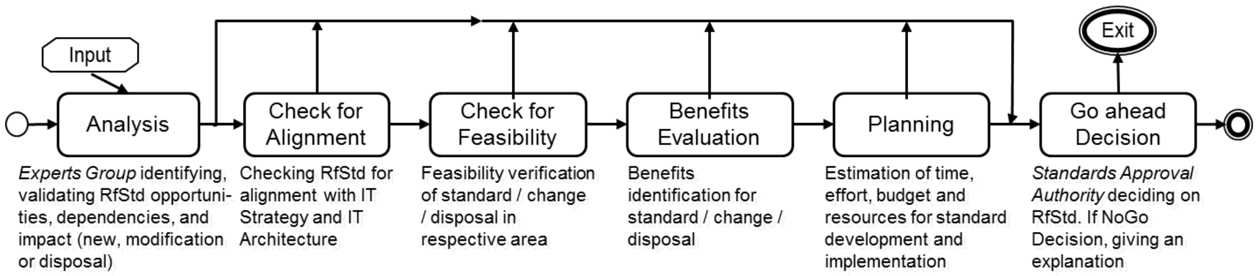

Fig. 4. SMP Phase 2 – Evaluation & Planning

6.3 *Phase 3: Drafting & Approval*

The purpose of the Drafting & Approval phase (see Fig. 5) is to plan, design, develop, and eventually test the standard solution and to identify and evaluate its impact on InduMaker's IT landscape. This should ensure compliance with corporate policies and with the company's IT Strategy and IT Architecture. Latest at the end of this phase, the Standards Approval Authority nominates the Standard Owner. The required deliverables of the Drafting & Approval Phase is an official documentation of the standard which is handed in for approval by the Standards Approval Authority. The standardized template (see Appendix 2 for an abbreviated template) serves for the documentation of the Standard. It includes the naming and description of the Standard, the implementation plan, the expected time frame, the expected roll-out costs, and the critical success factors for the standard to impact InduMaker's Business / IT Management, and – in case of procurement – a sourcing proposal, supplier (frame) contracts, as well as licensing agreements.

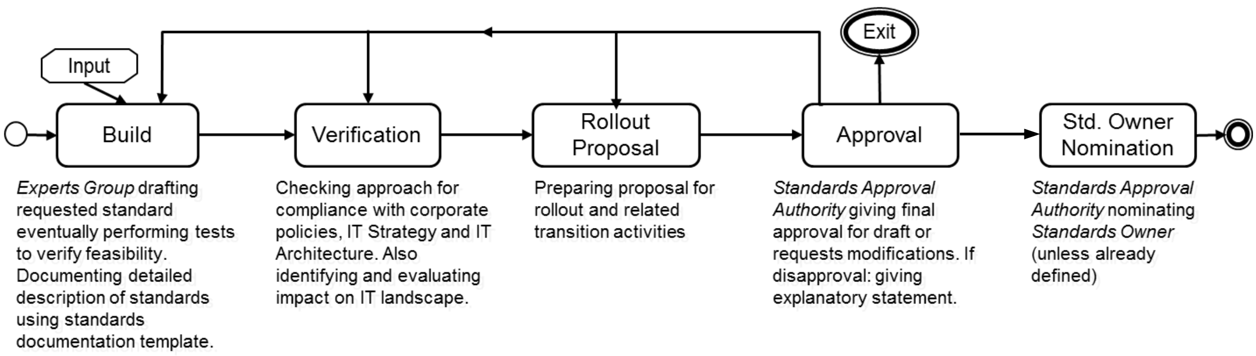

Fig. 5. SMP Phase 3 – Drafting & Approval

6.4 Phase 4: Implementation & Establishment

In this phase, the Standard Owner organizes the publication of the standards documents in the Corporate IT Homepage titled 'Standards and Methods'. He collects the acknowledged receipt by the IT management to ensure that everybody is aware of the new standard. The Standards List will be updated. These activities enable the supporting IT organizations to implement the standard as designed and to carry out awareness campaigns and trainings. In case of a standard disposal, all necessary clean-up activities are performed. Fig. 6 illustrates the steps of Phase 4.

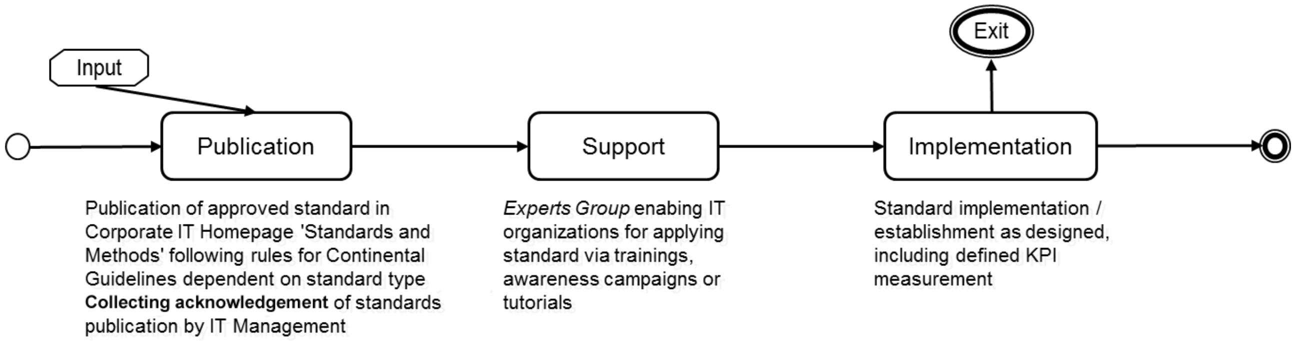

Fig. 6. SMP Phase 4 – Implementation & Establishment

6.5 Phase 5: Operation & Maintenance

The goal of Operation & Maintenance is to conduct a thorough review and assessment of the standard concluding with a clear assessment. Review results include reports on KPI measurements. This entails measuring standard compliance and implementation quality. The Standards Owner initiates assessments with regard to the scope, the level of obligation and the applicability of the standard – on request or as pre-defined for the standard. Thereby InduMaker can ensure firstly standard usage by measuring standard compliance and the degree of standard penetration and adherence and secondly the quality of its implementation. The Standards Owner collects the KPI reports from the IT organizations and prepares them for the Standards Committee. Fig. 7 summarizes Phase 5.

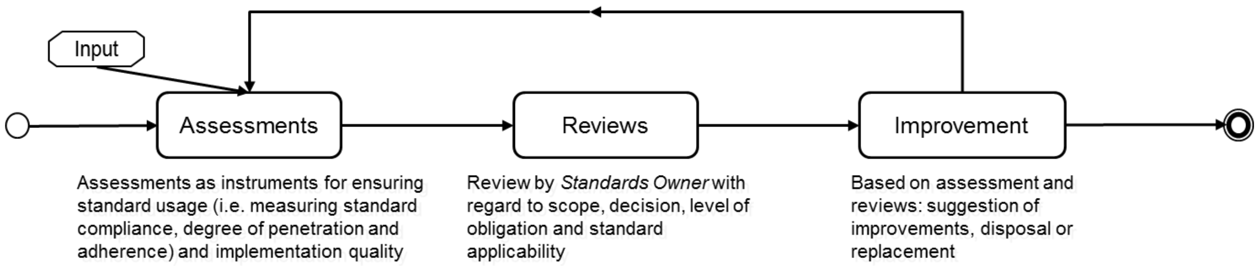

Fig. 7. SMP Phase 5 – Operation & Maintenance

6.6 *Phase 6: Replacement & Disposal*

During Replacement & Disposal (see Fig. 8), the Standards Owner – typically supported by the Experts Group – evaluates the implemented standard with respect to its future strategic and technological positioning. They also look into need for replacing or retiring the standard.

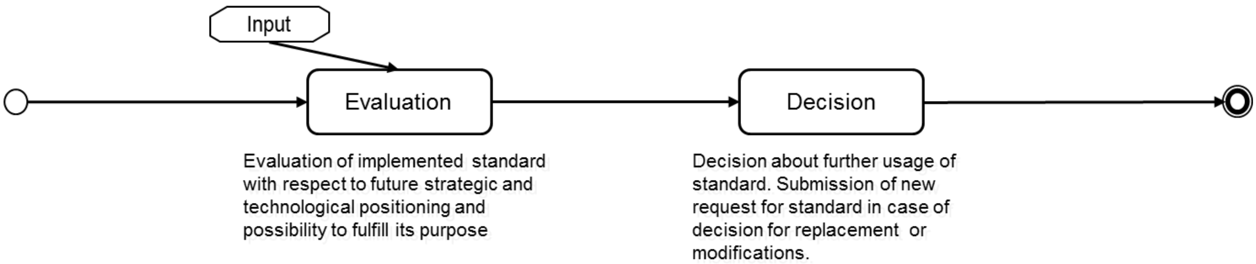

Fig. 8. SMP Phase 6 – Replacement & Disposal

7. Key Performance Indicators (KPIs) applied along InduMaker's SMP

Throughout the SMP, clearly defined and operationalized KPIs play an important role. This ensures customized and highly granular information about a particular standard in progress during any phase of the SMP. Many of those KPIs have to be collected manually and so bind relevant person-power resources. So it must be clearly communicated for what any particular piece of information is needed. Here, the Intranet Standards & Methods site serves as a commonly accessible source of information. Table 3 summarizes the KPIs calculated throughout InduMaker's SMP.

Table 3. Key Performance Indicators in InduMaker's Standard Management Process

No	Phase	KPI	Measurement Method
1	RfStd*	No. of requests for standard per year	Count standard requests in 'Standards Request Record'
1	RfStd	No. of change requests for existing standards	Count requests for existing standard in 'Standards Request Record' of request type: change
1	RfStd	No. of disposal request for existing standards	Count requests for existing standard in 'Standards Request Record' of change type: disposal
1	RfStd	Percentage of accepted requests	No. of accepted requests / Total No. of standard requests * 100
1	RfStd	Time to feedback on acceptance note	Count time between 'request date' and 'acceptance date' in 'Standards Request Record'
2	Evaluation & Planning	No. of evaluated standard requests	Count requests for standard having an acceptance date in 'Standards Request Record'
2	Evaluation & Planning	Percentage of accepted requests for implementation	No. of accepted requests / Total No. of standard requests * 100
3	Drafting & Approval	No. of approvals	Count all approved standards in 'Standards Request Record'
3	Drafting & Approval	No. of disapprovals	Count all rejected standards in 'Standards Request Record'
4	Implementation & Establishment	No. of Standards with implementation definition documented	Count all standards with a 'procedure to measure standards adherence' documented

4	Implementation & Establishment	No. of implemented / established standard solutions	Count all standards with the status 'implemented' in accordance with the 'procedure to measure standards adherence' documented
4	Implementation & Establishment	Result of implementation compared to planning efforts in previous phase	Restricted to cases with effort planning and effort tracking, e.g., effort planned vs. effort spent
5	Operation & Maintenance	Satisfaction level (goal: xx% – except for regulations)	Stakeholder survey, on demand
5	Operation & Maintenance	No. of standards violations per standards type	KPI not implemented initially
6	Replacement & Disposal	Percentage of reviewed standards	No. of standards with actual review date / total no. of standards to be reviewed *100
6	Replacement & Disposal	Percentage of disposed standards without replacing	Count standards with life cycle status 'disposed' not mentioned under Replaced Standard of another standard record / total no. of disposed standards *100

* Request for Standard

8. Assessing InduMaker's Standard Management Process

By analyzing of interview and workshop protocols and digging into first requests for standards going through the SMP, we found that with the SMP InduMaker has reached several main achievements, but also faced some critical issues causing quick process interferences. First and foremost, the development and the adoption of the SMP has led to remarkable awareness and has caused managers and employees to buy-in into an initiative which typically finds itself rather at the bottom of anybody's priority list – standard management. In particular, with introducing the SMP, InduMaker has achieved several project benefits:

- *Unified understanding and communication throughout InduMaker at its 190 locations*. Before having installed the SMP, InduMaker found considerable differences among managers and employees in views and expectations, knowledge, culture and habits between stakeholders and acting persons with regard to basically any topic that may be considered for standardization. Here, the SMP helps achieving company-wide unified understanding and communication as it clarifies the term 'standard' and related terms throughout the company. The SMP not only offers a precise definition of standard categories that appear to be useful in InduMaker's IT, it also streamlines the way in which InduMaker describes and documents a standard along the phases of its Life Cycle Process including details of the logical flow. Finally, in terms of unified understanding and communication throughout InduMaker, the SMP fosters adjustment with other repositories of IT-related documents at InduMaker;
- *Increased awareness of a Standard Life-Cycle*. Already after a year, the introduction of the SMP had achieved rising management attention within InduMaker concerning the importance of managing company-wide standards, which has been found to be 'mission-critical' [12]. Further, data show a traceable buy-in into the resource-binding effort from all continents, even though the adoption of the SMP follows common adoption patterns. It took InduMaker explicit initiative to generate a 'critical mass' of standard requests in order to attract staff to think of standards beyond gut feeling. After a slow start, InduMaker has provided individual support to understand the process and to get familiar with the formalized way of the documentation of the standard. At the beginning, the number of requests has risen slowly, after about a year, the SMP track record shows about 15 requests for Standard per quarter – more than one had hoped for;
- *Improving communication with external providers and seamless and interoperable systems integration*. For InduMaker, the SMP lays the foundation for seamless and interoperable systems integration and provides a reliable framework for designing future IT enterprise solutions – which confirms both findings from the related literature on business process modeling [13] and business process commoditization [1];

- *Enhanced cross-corporate support for approved standards*. In line with [27], the acceptance of and the subsequent adherence to approved standards has improved due to the 'democratically' involving case-specific Expert Groups and assigning an Approval Authority based on topical competence;
- *Focused demand orientation of standard settings*. InduMaker requires a specific demand to initiate a standardization request. Ideally, anybody who sees a potential need to establish a standard, process or product, can forward a Request for Standard. At least during the first years of deploying the SMP, this prevents pursuing top-down standard settings following a predefined programmatic list of issues to be covered – and thus saves resources and again increases support for and adherence to standards as suggested also by earlier works on business process deployment [1, 10].

However, deploying the SMP also brought about four main weaknesses – which in part have already been addressed by InduMaker with early on countermeasures:

- The 'bottom-up/democratic' approach to standard making risks flooding InduMaker's SMP with too many standardization requests of minor relevance [15, 22]. To accommodate this weakness as much as possible, the process was initially set active with restricted proposal sources;
- The large number of detailed rules and KPIs sometimes comes across as 'over-kill'. Concerns have come up especially regarding the large number of KPIs that have to be collected and analyzed manually. Some KPIs are to be tracked in the beginning and adopted during the phases; this applies for instance to 'Request Cycle Time', '# requests', '# requests rejected', '# approved standards'. Managers in the field often do not really 'know who needs to know or who wants to know'. The embedded problem of incompatible or intransparent goals and requirements across company units has already long been recognized in the literature on standard making [7, 13]. To eliminate the time consuming effort for manual evaluation, implement an SMP with a significantly reduced number of KPIs excluding all those which cannot be analyzed automatically;
- Different from the goal of clear and visible decision and responsibility structures embedded in SMP roles, ongoing discussions and different understanding of the role and the responsibility of the standards committee and the approval authority show that either the role profiles are not clear enough or they are not wanted away from the headquarters. InduMaker installed a Secretary General for SMP to handle the requests – registration, quality checks of requests and documents, tracking, etc. and to take over the coordination and help function for staff new to the process;
- The SMP, in its strictness, is not too easy to understand as a whole. It requires tutoring or at least the willingness of the stakeholders to spent some time and effort in practicing with first cases. The complexity of the SMP might be in conflict with particular company-internal values, such as technical purity [2, 7].

9. Lessons learned, implications and limitations

In the case of InduMaker, an explicit standards management with clearly defined phases, responsibilities and KPIs supports the process transparency, provides standardized documentation, and allows for corporate-wide accessibility and awareness. Such management of internal standards leads to traceable identification of exceptions and overall to shorter standard implementation cycles at new locations, transparent decision processes and criteria, and thus internal efficiency gains measured in numerous KPIs.

The study shows the case of grounding many IS decisions, e.g. the ones of choosing and deploying internal standards, on sometimes complex, but clearly defined methods and approaches. InduMaker takes the decisions based on pursuing some – in long management rounds – agreed-upon 'steps' with clear KPIs and then enforces those 'steps' company-wide in a standardized manner. Here we see similarities to multinationals who seem to apply complex detailed methods on a global scale, for instance for assessing cloud readiness [24], even when weighing local contextual differneces against the benefits of procedurally sound, company.wide selection or management rules.

It is to be debated to what extent and based on which measures the advantages of a company-wide management of internal standards can be balanced against the resources required in the context of any company-wide SMP, which – by definition – implies the risk that a standard leads to an unwanted 'mono-culture' which is susceptible to crisis and binds extensive skills and resources barring other fast and agile IT developments processes.

Considering the implications of our research, we wish to point to two constraints, which we frequently face in practice-oriented research efforts: Firstly, it has required some confidentiality time period (of nine months) to secure the publication opportunity for the case study on a newly developed and implemented, company-internal standard management process. As InduMaker assesses some of our research findings as rather critical for the company and some of their employees have posed some constraints in terms of data release.

Secondly, as with any single case study, the current insights are highly preliminary. They may not be fully generalizable to other multinationals, business and IS processes or standard setting procedures with different motivations and contexts. Therefore, we prefer positioning our work as an investigative illustration of a company-wide IS standard management process and aim at creating awareness.

Harking back to Cheng and McKinley [16], we claim that our work meets the three main criteria for organization research: (1) *relevance*: the issue of managing company-wide IS procedures (here IS standards) is highly relevant to many multinationals, particularly in case of ongoing mergers and acquisitions of organizational units with historically different approaches; (2) *applicability*: insights and lessons learned are applicable to other (non-IT) multinationals which likely deploy comparable corporate IT infrastructures to run and support their core business, and (3) *specificity*: differentiating six phases, each with a number of specific steps, tasks and stakeholders within InduMaker show a degree of specificity which is rarely found in scientific research. Admittedly, at some point, such specificity supporting rigor in qualitative research [16], conflicts with the general research aim of generalizability. Here we invite other researchers to replicate in different settings and validate or expand the insights gained. Furthermore, we also call for more research attention to managing internal IS standards. Such work should take multiple viewpoints, including the company, internal and external stakeholder groups, and individuals.

We hope this case research can serve as an effective eye-opener and promote further investigations in a seemingly trivial, but barely solved IS management problem impacting corporate scope.

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Appendix 1a. Abbreviated Requests for Standard (RfStd) – Example

Standard Request: Internet Guest Access Planning Manual

Standards Request:	**Internet Guest Access Planning Manual**
Date: 19.02.2013	Document No.: XXX
Request Description	Standardization of Guest Internet Access possibilities and definition as a Service (e.g. for Access Security and rights, Voucher classes, Sponsor portal, Internet access, tested Hardware, Management tool), independent of the InduMaker internal Internet Access (CIAS) and internal networks.
Motivation	Guest Access in InduMaker locations frequently demanded; security and legal regulation have to be ensured.
Standard Type	Regulation - mandatory
If 'Regulation – mandatory', is this a candidate for policy, manual or instruction?*	No
Object	Specification (WLAN hotspot in InduMaker locations)
Organizational Scope	Corporate
Area of use	Internet Guest Access Service
Benefits	Globally unique implementation set-up and quality, operational guideline, uniform Access rights and control on IEEE 802.1x standard, cost efficiency, internet access with no interconnection to the InduMaker network infrastructure.
Documents available	No
Request agreed	Yes
If Yes, by whom	IIC & ISC
Requester	First Requestor
Approval Authority	List of names of specific AA
Experts Group	List of names from Competence Group Network&Voice (anonymous))
Standards Owner	One Owner
Date of Acceptance	

* These are other, higher level categories of the InduMaker's repository of enterprise documents.

Appendix 1b. Abbreviated Requests for Standard (RfStd) –Example

Standard Request: Desktop Search

Standards Request:	**Desktop Search**
Date: 08.03.2012	Document No.: S 10.000007
Request Description:	Standardizing Desktop Search tools in the context of DS7, DS, DE, CAT Products: WDS and EZ Notes Adapter.
Motivation	Improvement of desktop usability function (Search) part of the ConNext concept.
Standards Type	Regulation - mandatory
If 'Regulation – mandatory', is this a candidate for policy, manual or instruction?*	Yes
Object	Client Software
Organizational Scope	Corporate
Area of Use	Managed User Workstation Services
Benefits	Higher degree of automation of DS7 client rollout. Applicable for older clients (DE, DS, CAT)
Documents available	Yes
Request agreed	Yes
If Yes, by whom:	CAC Voting members
Requester	First Requester, another Requester
Approval Authority:	List of CAC voting members, IIC
Experts Group:	List of names of global IT Client Support Team
Standards Owner:	Application Portfolio Manager (name)
Date of Acceptance:	

* These are other, higher level categories of the InduMaker's repository of enterprise documents.

Appendix 1c. Abbreviated Requests for Standard (RfStd) –Example

Standard Request: Process Management Principles

Standards Request Date: 31.01.2012	**Process Management Principles** Document No.: XXX
Request Description	Standardization of methods for process management in InduMaker IT including: - The standards for documenting process information; - The roles and responsibilities of process management; - Boundaries, principles and rules in the definition of InduMaker's IT processes.
Motivation	Processes are currently described/documented in many different ways. Prerequisites for a common process management framework.
Standards Type	Regulation – mandatory
If 'Regulation – mandatory', is this a candidate for policy, manual or instruction?*	No
Object	Process Management
Organizational Scope	Corporate
Area of use	All IT processes at InduMaker.
Benefits	All process design follows a common systematic of description. Transparency and common understanding of process structures, flows, involved roles, processed objects, and interfaces between processes. Enabling clear and consistent visualization, modeling and management of all relevant processes.
Documents available	Yes
Request agreed	Yes
If Yes, by whom:	CCI SI
Requester	One Requester, Another Requester
Approval Authority**:**	Corp CIO Team (names)
Experts Group:	Corp IT Strategy and Competence Group Service Integration (names)
Standards Owner:	One Owner
Date of Acceptance:	

* These are other, higher level categories of the InduMaker's repository of enterprise documents.

Appendix 2. Standard Documentation: Standard for File Compression

Objective of the Standard
A consolidated and useful application for the basic functionality 'File Compression'.

Who should use this document
Primarily intended for all service providers who are requested and affected in software request and installation (e.g. Service Desk, Local IT, Software and License Manager) as well IT Management, Service Owners, IT Architects, IT CCs.

Motivation for Standard
Due to Bug in current standard tool IZarch (Encrypted archives with AES256 and greater as 100 MiB which end's in corrupted Data's) the standard has to be reviewed.

Evaluation / Recommendation
Software Candidates
- WinZip Pro 16
- Winrar 4.11
- IZArc 4.1.6
- ZipGenius 6.3.2.3110
- Filzip 3.06
- 7Zip 9.20

Recommendation
The features for tools evaluated are found to be ranging from basic compression tool to an advanced one. Since Winzip Pro has already been offered as an optional package with the advanced features, 7Zip will be recommended as an alternate compression tool as it is free and fulfils all the basic needs of a compression tool.

7Zip is available in 79 languages, supports compression/decompression to 7Z, ZIP and many other formats, encrypts files in AES-256, supports spanning, create self-extracting archive for 7z format and integrates with the windows shell.

Standards Description
7Zip is defined as new corporate standard for File Compression functionality. It is mandatory for all standard clients and has to be included in the standard core image.

Terms and Clarification – n/a
Applicability
The standard is valid corporate wide.

Benefit of the Standard
Improvement and elimination of current bug for the File Compression functionality.

Dependencies to other Areas
Dependencies to other areas: not known.

KPIs and Standards Compliance
KPI = number of installations
Compliance: 100% of standard-clients updated or installed with 7Zip.

Rollout Proposal / Description
See COBA Request for Package: RfP000743
Packaging for LanDesk
Dependencies-Check, Pilot, Release

InduMaker Policies n/a

Other Resources n/a

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A new approach to managing Lessons Learned in PMBoK process groups: the Ballistic 2.0 Model

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A new approach to managing Lessons Learned in PMBoK process groups: the Ballistic 2.0 Model

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Abstract:
In any organization, dealing with lessons learned is a complex issue that involves people, processes and technologies. Although lessons learned processes are already well established in the project management community, the use of modern web technologies to support them is still in its infancy. This paper introduces a new model to manage lessons learned in PMBoK process groups. This model draws upon interdisciplinary literature, which embeds lessons learned processes, shared context and Web 2.0 service models. The model is supported by Web 2.0 technologies and centered in PMBoK process groups to allow a thorough overview of the project. An exploratory focus group was set up to validate the model qualitatively within a constructivist ontology and an interpretive epistemology. The adoption of this model can help academics and practitioners using PMBoK process groups to acquire a better understanding of managing lessons learned in projects.

Keywords:
IT Project Management; PMBoK; Knowledge Management; Lessons Learned; Web 2.0 Technologies.

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1. Introduction

Learning in organizations is a concern that started long ago and still attracts attention nowadays. Senge [1] describes learning organizations as "organizations where people continually expand their knowledge to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together". One of the main challenges that organizations face, specifically project-oriented organizations, is little incentive or a lack of structure for long-term organizational learning [2]. Additionally, even when organizations provide an appropriate structure for learning, it is not usual for project teams to use stored knowledge from other projects [3]. This complex issue can be addressed with adequate lessons learned (LL) management, combining social interactions, informal dialogue and modern technologies. Unfortunately, LL approaches have received little attention from project management researchers and are underrepresented in literature [4].

Although LL management is covered by the main project management methodologies (PMMs), researchers have found critical gaps in PMMs. Wells [5] found that many practitioners (47.9%) rated the benefits of PMMs as low and considered that PMMs are unhelpful. This fact indicates that PMMs are using an approach that is out of phase with the needs of current projects. From all the issues covered in PMMs, LL seems to be the one with considerable room for improvement. The IPMA [6] and PRINCE2 [7] guides contain 42 and 57 occurrences of the term "lessons learned", respectively. As for PMBoK, LL has gained more relevance over the last years. The fourth edition of the PMBoK Guide referred to LL 44 times [8]. In the fifth edition of PMBoK [9], this term occurs 71 times. On the other hand, PMBoK has very mechanistic, rigid language, as opposed to LL, learning and knowledge, which are more organic and fluid [4]. In addition, PMBoK describes LL in a limited manner, focusing mainly in the closeout phase as administrative and documented outputs.

In fact, PMBoK seems to ignore the relevance of both knowledge management processes and LL methods [10;11]. PMBoK lacks a prescriptive approach to LL. "A theory of project management should be prescriptive: it should reveal how action contributes to the goals set to it" [12]. To adopt a prescriptive approach to address LL in PMBoK, one should focus on people, processes and methods, and technologies which can cross-cut all PMBoK process groups.

Levitt [13] asserts that PMBoK can be characterized as Project Management 1.0 (PM 1.0), since it lacks agility and a strategic view, being mainly operational, without employing all available knowledge. Besides, PMBoK's inflexible philosophy is heavy and ineffective, as it focuses on meticulous planning and control of large and extensive projects. In addition, BoKs deal with the project as decoupled from the environment [14]. In this context, a more adequate approach needs to emerge to face the challenges imposed by current dynamic projects. Project Management 2.0 (PM 2.0) is characterized mainly by autonomy and agility, which can meet the needs of team members and project managers [13]. PM 2.0 can be supported by Web 2.0 technologies such as wikis, microblogs and collaborative edition tools. These technologies can improve knowledge management in project management settings. Wikis, for instance, can enhance the learning process [15]. Wikis can be used as a central repository for information, allowing collaboration between organizations and solving the problem of information overload by e-mail [16]. Moreover, wikis are also considered in promoting innovation in organizations [17]. Microblogs have been used to improve project communication and documentation, to record LL in projects [18;19].

In order to contribute with a theoretical approach to PM 2.0, this paper considers that Web 2.0 technologies can help improve LL in contemporary project management practice. The adoption of Web 2.0 technologies, integrated with traditional LL processes, can be a way to make PMBoK guide more agile and flexible. Following this same line, instead of considering PM 2.0 as a surrogate for extant project management, it should be seen as complementary. Therefore, the goal of this research is to introduce a new model to manage LL in PMBoK process groups. This study was conducted within a constructivist ontology and an interpretive epistemology, and it is inductive in nature as it builds a model from data generated in a focus group. Moreover, it uses literature to establish links between Web 2.0 technologies, LL processes the interaction among project members (their shared context) and Project Management in PMBoK. Arguably, this research can contribute to both the theory and practice of Project Management by formalizing these links in an innovative model to add value for managing LL in projects.

This paper is structured as follows: Section 2 describes the theoretical foundations on which the proposal of this paper is based. Section 3 details the main contribution of this paper, a model to manage LL in PMBoK process groups. Section 4 presents the focus group carried out to validate the model proposed and its results. Section 5 introduces a discussion on the main issues related to the LL processes in project management. Finally, Section 6 concludes the paper and points out the research contribution ideas for further work.

2. Background

2.1 Lessons learned in literature

LL is a knowledge management mechanism defined by Secchi et al. [20] as knowledge acquired by both positive and negative experiences, and is therefore a guide to a better performance [21]. Lessons learned discipline has been studied in different types of organizations and areas in order to organize and improve their effectiveness. Literature contains lessons learned methods [11;25;39], processes [10;40], and also applications of lessons learned such as models and/or frameworks for knowledge management in projects [41;42]. Some special theories like Situated Learning Theory [43], which is an approach based on social aspects supported by architecture components (Learning Relations, Cognitive Style, knowledge management, learning Mandate and Authority of Pyramid), and the Mutual Caring Theory [44], which highlights psychological causes of the difficulties in sharing knowledge, appeared lately in an attempt to minimize some inefficient aspects of LL generated by the main character of the LL discipline: people.

The purpose of an LL system is to collect and supply lessons that can benefit those who encounter situations where the lesson can be applied [10]. PMI [9] defines LL as “the knowledge gained during a project which shows how project events were addressed or should be addressed in the future with the purpose of improving future performance”, and the LL knowledge base as a “store of historical information and LL about both the outcomes of previous project selection decisions and previous project performance”.

The processes of an LL system are (see Fig. 1): collect; verify; store; disseminate; and reuse. The following are brief descriptions of the processes:

- **Collect:** There are four ways to perform this process. In passive collection, individuals submit their own lesson using a form. Reactive collection means LL are collected by interviewing the members of the organization. After-action collection is generally used by military organizations to collect LL after missions. In proactive collection, the lessons are extracted while problems are being solved. Active collection is an approach in which lessons are collected from within the organization. Finally, interactive collection uses an intelligent system to solve ambiguities by interacting with the authors of the lessons and relevant sources;
- **Verify:** This process is executed by a team of experts who are responsible for validating lessons according to redundancy, consistency and relevance;
- **Store:** This process refers to the representation, indexing, format, and storage of LL;
- **Disseminate:** This is the most important process regarding promoting the reuse of LL. Weber et al. proposed five dissemination methods [10]. In *passive dissemination*, users access lessons in a standalone retrieval tool. In *active casting,* lessons are broadcast to the members of an organization by a dedicated list server. *Broadcasting* is a form of disseminating LL by sending bulletins of LL to all members of the organization. *Proactive dissemination* is a method that uses a system to predict users’ need for LL by analyzing their recent events and sending LL to individuals proactively based on this analysis. *Reactive dissemination* is a method in which users can invoke a system to browse lessons;
- **Reuse:** As a rule, users are responsible for choosing to reuse lessons. Weber et al. [10] identified three categories of this process: *browsable recommendation,* in which the system displays the retrieved lessons; *executable*

recommendation is a method in which users choose to execute a specific lesson; and *outcome reuse*, in which the LL system retrieves the results of using a specific lesson, allowing users to know if the lessons are helpful or not.

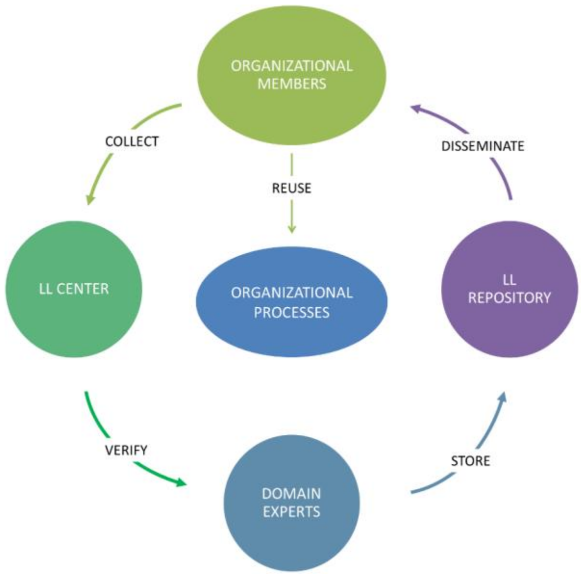

Fig. 1. A generic lessons learned process [10].

LL can be categorized as [10]: (a) informational (e.g. how employees' duties could be changed during times of emergencies); (b) successful (e.g. capture effective responses to a crisis); and (c) problem-oriented (i.e. describe examples of actions that failed and potential ways to resolve them). However, it is also suggested that lessons be categorized by their contribution rather than, or at least in addition to, the type of experience from which they are derived (e.g., success or failure). Lessons can be learned from each and every project, even if the project is a failure, but many companies do not document LL because employees are reluctant to report their own mistakes. Additionally, the organization structure and culture of the company can impact both sharing and using the LL of projects: if there is too much focus on schedule goals, and a non-holistic view of the projects, LL tend to be forgotten [45]. Thus, employees end up repeating the mistakes that others have made, which can be also related to "most companies prefer post-implementation meetings and case study documentation" [22]. The problem is when to hold the post-implementation meeting. One company that uses project management for new product development and production holds a post-implementation meeting to discuss what was learned when the first production run is complete. Approximately six months later, the company conducts a second post-implementation meeting to discuss the customers' reactions to the product. There have been situations where the reaction of the customers indicated that what the company thought they had done right turned out to be a wrong decision. A follow-up case study is then prepared during the second meeting.

2.2 Lessons learned in PMBoK

The practice guide in project management from the PMI's PMBoK defines LL as a basis of historical information and LL from the results of previous projects [9]. In this context, the manager and the project team are able to document issues, risks and solutions arising during the project, which can be useful in future projects. In addition to providing useful information for future projects, the basis of LL can provide feedback on implemented projects and assist organizations in portfolio management [9]. The collection, documentation, and use of the LL to solve problems is the project manager's responsibility [9].

PMBoK quotes artifacts of LL as part of the organizational process assets and corporate knowledge base. As part of the process assets, the LL artifacts can be used in and outside the ten knowledge areas (project integration, scope, time, cost, quality, human resources, communication, risk, acquisition and stakeholders) [9]. The fact that PMBoK [9] mentions LL as an artifact of entry and exit in all ten areas of knowledge implies that LL can be updated at all stages of the project. On the other hand, PMBoK does not prescribe specific methodology for documentation and sharing of LL, although the processes of creating, maintaining and sharing LL are mentioned as best practice for the maturity of organizational project management PMI (Organizational Project Management Maturity Model-OPM3) model [24].

2.3 Knowledge management: Shared context

Knowledge management is another central pillar in this paper. Nonaka, Toyama, and Konno [25] describe four types of knowledge: conceptual; systemic; experiential; and routine. Conceptual and systemic knowledge are explicit knowledge, such as product specification, manuals, documented information about clients. Experiential and routine knowledge are shared tacit knowledge based on the hands-on experience of project members, stakeholders and clients. Expertise, organizational culture and organizational routines are other examples of this kind of knowledge. The process of retaining experiential and routine knowledge is more challenging, given its tacit nature.

Nonaka et al. [25] present a unified model of dynamic knowledge creation on which this research is based. Their model unifies the Socialization, Externalization, Combination, and Internalization modes of knowledge conversion (SECI model), shared context (*ba*) and leadership. SECI is a well-known model proposed by Nonaka [26], where explicit and tacit knowledge interact in a continuous process. *Ba* roughly means place and is defined as a “shared context in which knowledge is shared, created and used” [25], since knowledge needs a context in order to exist. The main objective of *ba* is interaction. In the shared context, knowledge needs to be ‘energized’ (stimulated) in order to be active and to have meaning in the workspace. Considering that knowledge needs a physical context to be created, *ba* offers such a context for action and interaction. *Ba* varies according to two dimensions: type of interaction (i.e. individual or collective) and media (i.e. face-to-face or virtual). From these dimensions, four types of *ba* are defined according to Fig. 2.

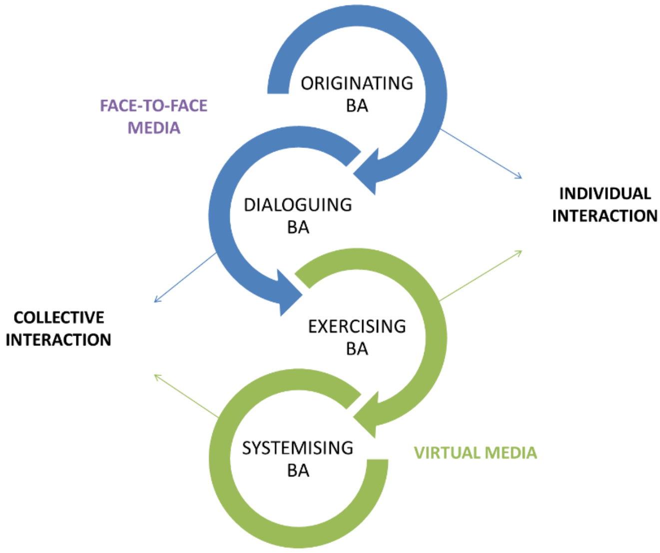

Fig. 2. Four types of *ba*. [25]

Originating *ba* offers a context for socialization, since the individual face-to-face interactions allow for the sharing of tacit knowledge. Dialoguing ba offers a context for externalization, as an individual's tacit knowledge is shared and articulated through dialogues among project members. Systemizing ba offers a context for the combination of existing explicit knowledge, which can be transmitted to project members in written form, e.g. wikis, web-based office. Exercising *ba* offers a context for internalization, since individuals embody explicit knowledge that is communicated through virtual media, such as written manuals. Project settings are adequate to implement all types of *ba*, but literature has not yet reported results applying this model to project management. Also according to Nonaka et al. [25], middle managers are at the center of the knowledge-creating process. Project managers can be considered middle managers and they perform a key role to deal with knowledge management processes.

The Nonaka, Toyama and Konno unified model allows dynamic interactions between organizational members, and between organizational members and the environment [25]. These features make this model suitable for the context of project management. In addition, *ba* is appropriate to the dynamic Web 2.0 environment, since it is an open place where project members with their own contexts can come and go, and the shared context (*ba*) can constantly evolve.

2.4 Web 2.0 and service models

O'Reilly [27] defines Web 2.0 as "the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an 'architecture of participation', and going beyond the page metaphor of Web 1.0 to deliver rich user experiences". In fact, Web 2.0 is more dynamic and interactive than its antecessor - Web 1.0. Web 2.0 allows users to access and update Web content faster.

For Thomas and Sheth [29], the major impact of Web 2.0 was the change that occurred with the information being brought by the user. Although Web 1.0 technology allows the reading and recording of information, only in Web 2.0 can users take advantage of this capacity in large scale. The main benefits of using Web 2.0 tools in organizations is the sharing of ideas and the access to organizational knowledge [30].

Web 2.0 platform is a propitious way of developing dynamic and collective learning [28], [29], [31], [32] and promotes continuous interaction between tacit and explicit knowledge. For this reason, Web 2.0 technologies make the process of knowledge creation easier - as the process of knowledge creation proposed by Nonaka [26]. Shang et al. [32] designed a model of knowledge creation, combining Nonaka's SECI model and Web 2.0 technologies. Table 1 shows a brief explanation of the four service models for knowledge creation.

Table 1. Description of the four Web 2.0 service models [32]

Service Model	**Description**	**Web 2.0 applications**
Exchanger	Enables knowledge socialization and externalization with low control mechanism. The content of this service model is neither organized nor systematized.	VOIP calls, chat, e-mails.
Aggregator	Enables the knowledge creation cycle from socialization to externalization. The control mechanism is low. Users can share and aggregate information in many ways (video, sound, text).	Blogs, bookmarking, RSS, social networks.
Collaborator	Enables the full cycle of knowledge creation. Users can recreate content and applications. Contains processes for feedback.	Wikis, bookmarking, office applications, games, programming languages.
Liberator	Enables the full cycle of knowledge creation. In this platform, source code is open to users so they can improve it continuously.	Operating systems, Web 2.0 tools, games, programming languages.

3. Research Design

3.1 Developing Ballistic 2.0: A model for managing lessons learned in PMBoK process groups

Technologies, people and processes are the elements that compose the model proposed in this paper. Fig. 3 presents an overview of the Ballistic 2.0 model (Ballistic 2.0 stands for *Ba Lessons Learned Information Technologies 2.0*). To manage LL in PMBoK process groups, we analyzed the main LL processes in literature and selected the most appropriate for contemporary project management practice. After this, we identified the main knowledge management processes and theories regarding knowledge creation. We opted for the SECI model, which also recommends the use of *ba* (shared context). We used SECI, focusing on LL and not specifically on the creation of new knowledge. Finally, we chose the most adequate Web 2.0 Service models - Exchanger, Aggregator, and Collaborator - proposed by Shang et al. [32] to support the processes defined to compose Ballistic 2.0.

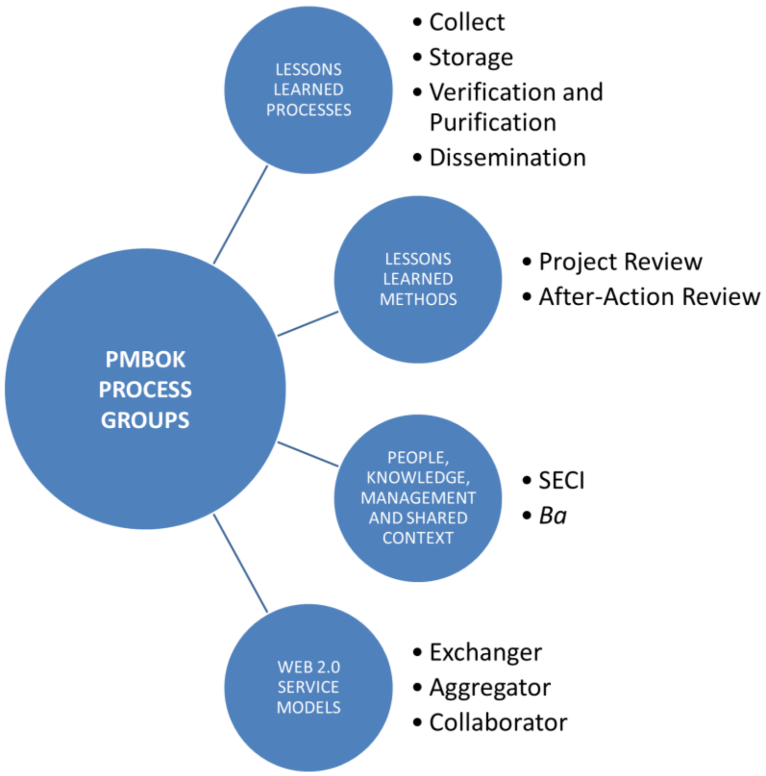

Fig. 3. Main components of the Ballistic 2.0 model

Fig. 4 shows how Web 2.0 service models support the concepts of *ba*. Although originating *ba* and dialoguing *ba* are accomplished with face-to-face interactions, Web 2.0 Service models can serve as a technological platform to store the output of individual and collective interactions, i.e., the LL can be captured using both of them.

Fig. 5 outlines a new model to manage LL in PMBoK. Based on literature [10;11;25;32], our proposal adopts the following processes in the LL life cycle: Store; collect; verify and purify; and disseminate. Most of them come from Weber et al. [10], except purify, which is also a contribution to this paper. Ballistic 2.0 is supported by the LL processes described by Weber et al. [10], *ba* as shared context defined by Nonaka et al. [25] and the service models introduced by Shang et al. [32]. It means that Ballistic 2.0 takes into account processes, people, and technologies. It is also centered in PMBoK process groups to allow a thorough overview of the project.

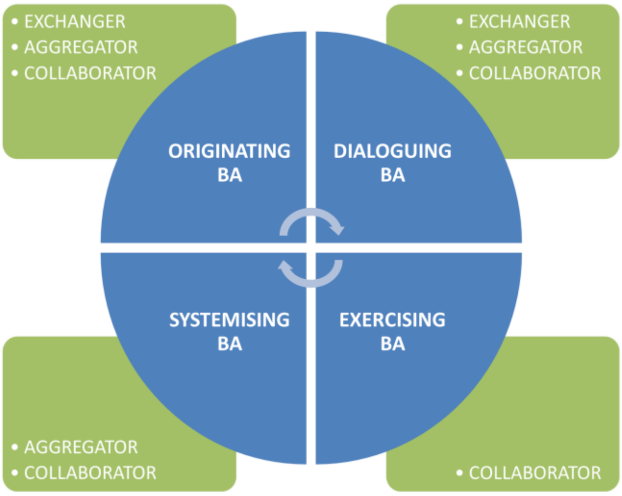

Fig. 4. *Ba* 2.0 – Extending *Ba* with Web 2.0 Service Models

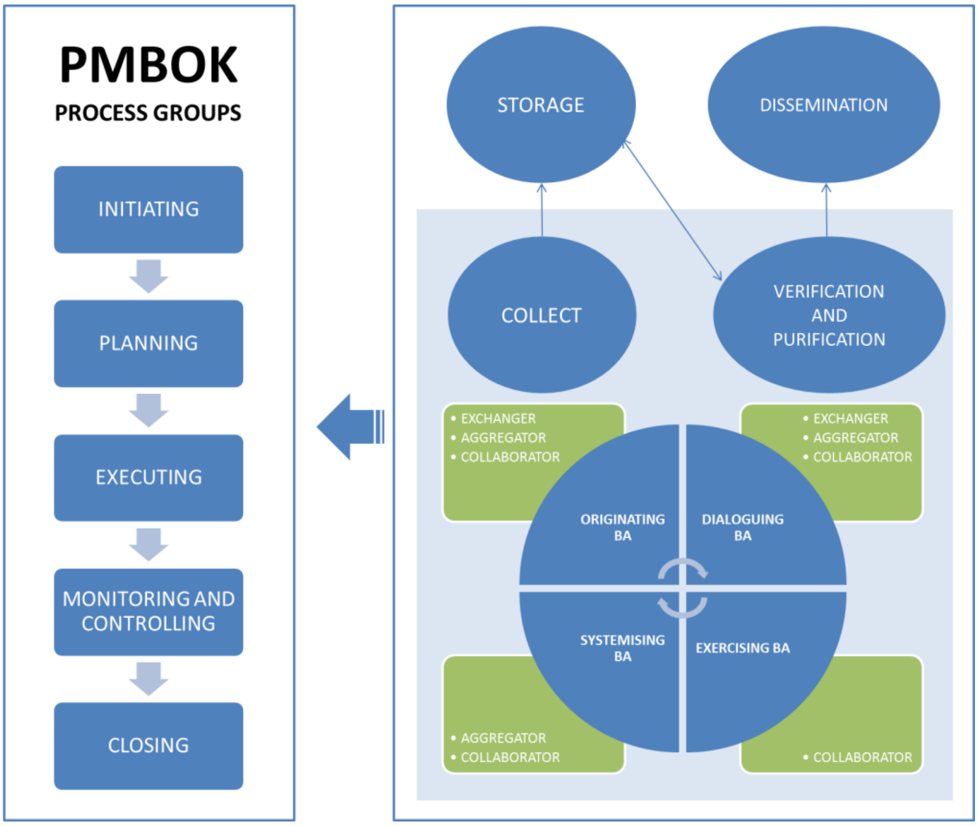

Fig. 5. Initial Ballistic 2.0 model to manage lessons learned in PMBoK process groups

Regarding technologies, collaborator and aggregator Web 2.0 service models support exercising *ba* and systemizing *ba*, covering individual and collective interactions using virtual media, respectively. Originating *ba* and dialoguing *ba* provide the context for socialization and externalization, respectively. The output of both can be stored in some of the Web 2.0 technologies proposed in exchanger, collaborator and aggregator Web 2.0 service models.

LL processes use the shared-context (*ba*) to help project managers to deal with learning in projects. Both the collect, and verification and purification processes are achieved using all four types of *ba*. Originating *ba*, dialoguing *ba*, exercising *ba*, and systemizing *ba*. The store and dissemination processes are related to Web 2.0 technologies. The store process can be implemented using the aggregator and collaborator service models, and the dissemination process can be accomplished using the exchanger and aggregator service model.

Although PMBoK process groups cover a set of processes, we focused on the specific use of Ballistic 2.0 in each PMBoK process group in the description ahead. We also used the Collaborator service model in the examples, since it covers all types of *ba*. Moreover, we assumed the adoption of a corporate wiki as the technological base to implement the LL processes proposed by the Ballistic 2.0 model.

3.1.1 Initiating

As regards PMBoK process groups, the Initiating phase seeks to understand stakeholder expectations, defining the project scope, project success criteria, initial resources, and to authorize the project at the end of this phase. Since it is the first process group, it will be the moment to promote *ba*. Originating *ba* and dialoguing *ba* should be encouraged if project members share the same physical place. In addition, systemizing *ba* and exercising *ba* can complement the search for LL in this kind of project. On the other hand, global projects should use systemizing *ba* and exercising *ba* due to the difficulty in holding face-to-face meetings. By using systemizing *ba* and exercising *ba*, project members are able to capture explicit and tacit knowledge in virtual and non-virtual projects.

Moreover, this is also the time to start reviewing the LL repository to search for LL retrieved in previous projects that may be reused in the new project. The project manager should consult the LL repository (e.g. legacy LL systems, corporate wikis or project blogs). The LL obtained from previous projects serve as input to initiate actions in this phase, and even to define possible risks beforehand. The LL can be also used to define the project charter more accurately or even to help sponsors decide whether projects should be authorized or not.

3.1.2 Planning

In the planning process, the project management plan is defined, in addition to the project documents that will be used throughout the project. This is an iterative, ongoing process, for it should be revisited whenever new information is obtained that requires the changing of the plan. The four types of *ba* supported by the exchanger, aggregator and collaborator Web 2.0 service models are suitable for this phase. These Web 2.0 service models will support a clear communication with stakeholders, mainly with the project team members who are responsible for dealing with the LL. For example, a wiki or a blog should be configured to facilitate communication with stakeholders. Although this paper focuses on lessons learned, the use of Web 2.0 technologies may be also extended to a wider scope such as knowledge management in a project.

As in the previous process group, it is possible to reuse LL from other projects in order to identify possible risks, to work package valuation and other necessary actions. Since the process is iterative, LL from the project itself can also be reused. Therefore, the reuse of LL may increase for the sake of delivering the project on time and ensuring the highest possible quality.

3.1.3 Executing

This phase is composed of several core tasks, including acquiring, developing, managing the project team and distributing information. Specifically, Web 2.0 service models can support the task of distributing information. Encouraging individual and collective interactions can facilitate the comprehension of the distributed information. New LL tend to emerge from these interactions and can be stored using Web 2.0 technologies such as wikis and blogs. The

LL dissemination process (i.e. distributing information) could be also implemented using corporate social networks, RSS and microblogs.

The executing phase enables both the application of LL and the capture of new learning items. The four types of *ba* can also be applied in this process group supported by Web 2.0 service models. For example, when project team members consult solutions in a wiki, they are applying the reuse process. The processes of Collect, Verification and Purification are also applied in this phase. During the executing phase, when project members face some difficulty or an unexpected situation, they can consult the corporate Wiki and verify if members of other projects experienced similar situations. In this way, they can access the repository and if it is applicable, reuse the solution provided. If that specific LL is not useful, project team members can update the corporate Wiki with a new LL. In addition, problems gathered during the meetings must be included as LL in the corporate Wiki with "In Progress" status. Then, these lessons should be analyzed and a solution provided. If this solution works, then the status should be updated to "Resolved", as per the agreement of both the team and the project management. After this classification, the lesson item can be purified and made available with "Finished" status. A project team member or project manager can do the purification of the items.

3.1.4 Monitoring and Controlling

In the monitoring and controlling phase, project managers can use the Ballistic 2.0 model to create more assertive control processes in projects. Adjustments to budget, timeline, or the desired end-product are often necessary to address unforeseen circumstances. Capturing LL at these times is a challenge for project teams. As Fig. 5 shows, the four types of *ba* support the task of capturing LL.

Project managers need to keep stakeholders up to date with project progress and team performance through reports and ongoing documentation. Web 2.0 technologies facilitate access so the team can quickly find the last adjustments in the project. Moreover, Web 2.0 technologies support stakeholder engagement, as in the history log in a wiki, the number of posts and comments in a blog or microblog, and active participation in corporate social networks. These examples of interactions should use systemizing *ba* and exercising *ba,* which offer a context for combination and internalization, respectively.

In addition, the monitoring and controlling phase is the appropriate moment to establish continuous purification of the lessons retrieved in the corporate Wiki. Following the example given in the executing phase, the lessons marked with "Resolved" will change to "Finished". We recommend that the members responsible for purifying the lessons should not be the ones who created them. For this reason, other people with the required expertise should be designated to purify the lesson.

3.1.5 Closing

The closing phase can be the last moment to collect LL. The Ballistic 2.0 model supports project managers by integrating LL processes with the shared context by team members and Web 2.0 service models. This is the time to create an environment to perform the four types of *ba* using both individual and collective interactions. Closing is also the moment to include the last LL with "Resolved" status. Then, these LL should be purified and receive the status "Finished".

3.2 Validating the Ballistic 2.0 model with focus group

Focus groups have been used to evaluate both the use of Web 2.0 technologies in organizations [33] and LL models in projects [34]. We set up a two-hour qualitative exploratory focus group in order to validate the Ballistic 2.0 model. Since Bloor et al. [35] suggest a focus group with six to eight participants; we recruited seven people who work in project settings to participate in the focus group. Since the success of a focus group session depends a lot on the dynamics between the group members [35], we established some criteria to select participants. The criteria were: 1) Participants should work in project settings; 2) Participants should have different professional backgrounds; 3) The group should have a balance of senior and junior professionals; 4) As far as possible, the group should be composed of professionals from distinct business sectors. We established these criteria to allow participants to contribute with different perspectives as well as to ensure that the generalness of the Ballistic 2.0 model would be applicable in all types of projects settings. Another reason for creating these criteria was to avoid a biased discussion.

The group was composed of one architect from a small company in the real estate market; an IT systems manager from a large multinational chain of fashion clothing stores; one graphic designer in a small-size cooperative; an IT consultant from a large telecommunications organization; a project manager from a large company specialized in quality compliance in project settings; a project manager from a large-size insurance organization; and a project manager from a large company in the public sector. Obviously, due to the group's heterogeneity, the moderator had to be able to conduct the session in a way that all participants could share their opinions constructively, as recommended by Bloor et al. [35].

The audio of this focus group was recorded so that we could analyze the content of the discussions. The participants received A3 blank worksheets and a printed version of the model depicted in Fig. 5. A whiteboard and pens were also available so they could draw and write their ideas during the session. The session was divided in two parts: in the first part, the moderator presented the Ballistic 2.0 model and the constructs on which it was grounded (the *ba*, Knowledge Management, the Web 2.0 Service Models, the LL processes and the five process groups of PMBoK). In the second part, participants were invited to discuss the model, share their opinions and propose changes. The group was very receptive to the model and discussed it exhaustively and enthusiastically. At the end of the session, we had two different versions of the model, qualitative data rich in details and interesting contributions provided by all participants.

4. Analysis of the Results and Discussion

All participants understood the model and participated actively in the session. The four types of *ba* were among the most discussed issues. One participant commented that the intensity of each type of *ba* could vary according to the phase of the project "The need for formalization of knowledge in both Dialoguing *ba* and Exercising *ba* is more intense than in Originating *ba* and Systemizing *ba*". Another participant added: "The tools are to be used gradually, in accordance with the phases of the project". Regarding the design of the types of *ba* in the model, one participant suggested using different colors to represent the type of interaction of the different contexts of *ba*, facilitating the comprehension of the model: "As project members are not physically present in Systemizing *ba* and Exercising *ba*, you could apply a different color in this part of the model".

The adoption of Web 2.0 service models was highly criticized by the group members. Even though the participants understood the concepts of the service models well, they could not understand why some service models could apply to a specific *ba* type and others not: "It's difficult for me to understand why the exchanger and the aggregator (Web 2.0 service models) are null". For them, the three service models used in the Ballistic 2.0 model - aggregator, collaborator and exchanger - could apply to the types of *ba*. In fact, when we suggested exclusion of the Web 2.0 service models from the Ballistic 2.0 model, they all agreed. For the group, it was better to use Web 2.0 technologies alone because "there are many different Web 2.0 technologies that can be distributed within the four quadrants of the *Ba* (shared context), during the whole project cycle".

On the other hand, the use of Web 2.0 technologies received positive comments from participants. One participant said "Thinking about the agility of Web 2.0, I really like Wiki and blogs. They are dynamic and users can be notified through RSS feeds in case of any updates". One participant suggested the use of microblogging: "LL happens all the time and whenever the LL repository is updated, a message could be sent, via Twitter, to the project participants". Another participant suggested the use of short messages via WhatsApp. A third participant complemented this suggestion saying that she uses WhatsApp and SMS to communicate with her colleagues: "I attend to scale model meetings in which I have to decide what material should be applied… and I communicate with my teammates using SMS and WhatsApp. After this, we use e-mail to register the decision or the lesson learned".

All participants agreed with the participant who suggested that the "same tools be distributed in the four quadrants (Web 2.0 Service models)". Another participant added: "Depending on the phase of project, you cannot restrict the type of *ba* to just one type of tool or one service model". As the participants reached a consensus on this issue, we opt to simplify the Ballistic 2.0 model, removing the Web 2.0 service models. Fig. 6 presents the new version of the model, which is grounded in Web 2.0 technologies instead of service models. Web 2.0 technologies are represented in the center of the four types of *Ba*. This new model design seeks to represent the suggestions proposed by participants. One participant commented on the representation of the LL processes and the types of *ba* "you could illustrate the core processes (types of *ba*) and the support processes (LL processes)".

One factor that the participants strongly stressed was the need to represent the different intensities with which the *ba* shared context and the Web 2.0 technologies can be applied in the Ballistic 2.0 model. In their opinion, it is critical to consider that their application may vary depending on the project phase (or process group) "... in the initiation phase, we tend to communicate less. In the execution and monitoring phases, the level of communication is higher, and as we near the end of the project, the tendency is to communicate less as well (as in the initiation phase)". A participant affirmed: "Web 2.0 tools will be progressively used according to the project phases". Another participant added: "You could represent (the variance of intensity) by changing the size of the circles... you could draw circles of different sizes…"

Some participants suggested that the Ballistic 2.0 model be more generalist and not "tied to" PMBoK. They believed that the model should not be restricted to one specific methodology only. We declined this suggestion since the main purpose of the Ballistic 2.0 model is to fill a gap found in PMBoK regarding the implementation of LL [10;11].

Figures 6a and 6b outline the design of the model that resulted from the analysis of the focus group participants' suggestions and comments. Figure 6a represents the four LL processes: collect, verify, disseminate and reuse, as well as the Web 2.0 technologies which support these processes.

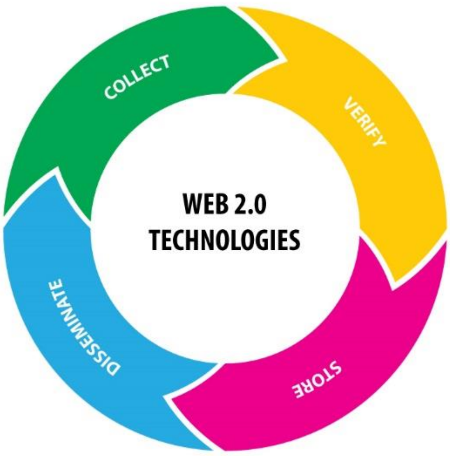

Fig. 6a. Layer-1 of the Ballistic 2.0 model validated with the focus group. Lessons learned (LL) processes and Web 2.0 technologies

In the new version, the model was divided into two layers. Layer-1, represented in Fig. 6a, illustrates the Ballistic LL processes, which contains the four LL processes adopted from the model of Weber et al. [10]: collect; store; verify; and disseminate. The LL processes are represented by a continuous cycle, which indicates that the LL processes should be repeated as much as necessary. In the center of the cycle, we placed the Web 2.0 technologies which should support all LL processes, as suggested by the focus group participants. During the focus group session, the moderator asked participants to describe examples of Web 2.0 tools that could be used in the Ballistic model. One participant suggested, "you should define one tool in the initiating phase of the project… later, you could include other tools". Other participants cited blogs, wikis, mashups, WhatsApp and Twitter as suitable tools to engage LL in project settings with dispersed teams. Their perspective is in tune with that of Gholami and Murugesan [31], who affirm that blogs, wikis, mashups and other Web 2.0 technologies can be used to improve team efficiency in global projects, as well as that of Auinger, Nedbal and Hochmeier [47], who found that wikis are suitable for sharing knowledge and record the project and blogs are adequate for communication and innovation. It is worth noting that the participants frequently mentioned the use of WhatsApp to generate LL. They mentioned the increasing use of WhatsApp in their companies: "WhatsApp is a very organic tool. Although we have not adopted WhatsApp as a corporate tool, we use WhatsApp more than Skype".

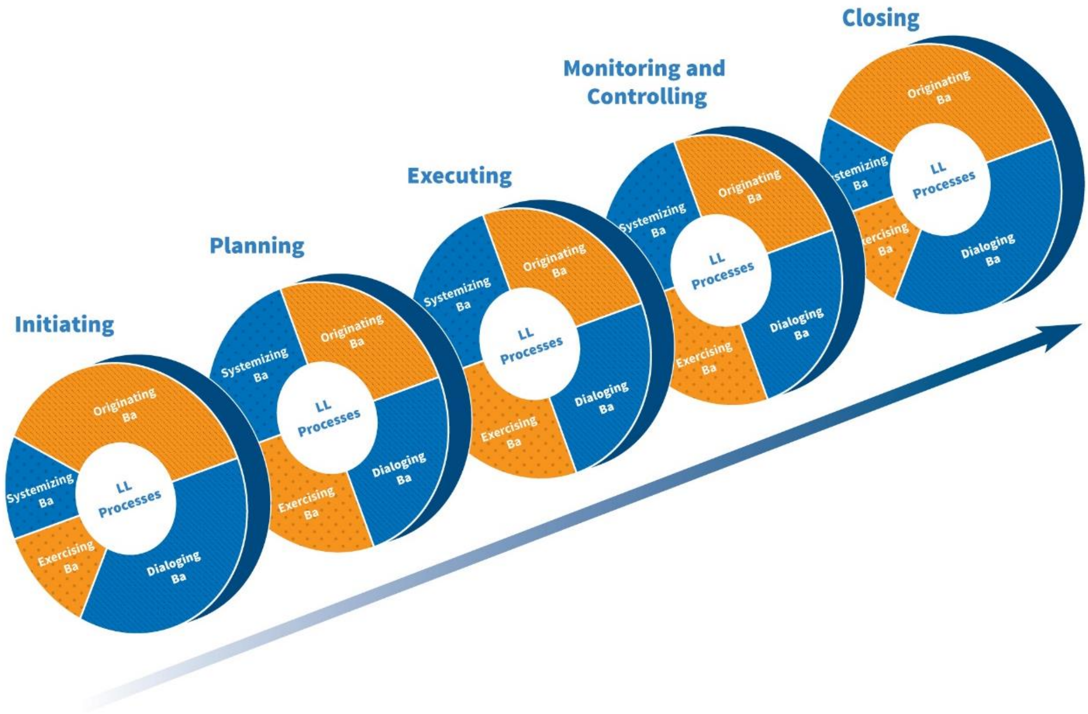

Fig. 6b. Layer-2 of the Ballistic 2.0 model validated with the focus group

In Fig. 6b, Layer-2 presents the combination of the Ballistic LL processes, the four types of *ba* and the five project phases. The four types of *ba* - originating, dialoguing, exercising, systemizing - are represented in the five circles, one circle for each of the five project phases - initiating, planning, executing, monitoring and controlling, closing. In order to represent the intensity with which each *ba* is used, we divided the circle into slices of different sizes. For instance, the slices representing the exercising and the systemizing *ba* are smaller than the ones representing the originating and the dialoguing *ba*. This representation indicates that the use of the exercising and the systemizing *ba* is less intense than the use of the other two types of *ba*. As mentioned above, according to the focus group members, the intensity with which the *ba* are used varies in accordance with the project phase. As commented by the focus group members, the dialoguing *ba* and the originating *ba* tend to occur more often than other types of *ba* in the Initiating and Closing phases of the projects. On the other hand, in the planning, execution and controlling phases, the four types of *ba* can be equally used to share LL within project team members. As suggested by one of the participants, we used the same texture to represent the systemizing *ba* and the exercising *ba*, to indicate that they consist of virtual interactions. Likewise, the originating and the dialoguing *ba* are represented by the same texture to indicate face-to-face interaction. We also used different colors to distinguish the *ba* in which there is individual or group interaction (orange for individual interaction and blue for group interaction). The Ballistic LL processes are in the center of each circle to indicate that LL processes take place in the four *ba* contexts. The Ballistic model goes through the whole project cycle, as indicated by the arrow in the bottom of Figure 6b. Project evaluation should happen in all phases of project life cycle [36] and "the main message is to break a paradigm of managing LL only at the end of projects… LL occur all the time and we can use different means to manage them, and use applications such as WhatsApp and Twitter..."

5. Theoretical and practical implications

5.1 Theoretical implications

The theoretical contribution of this paper lies in its originality, which can be characterized as incremental according to the definition proposed by Corley and Gioia [37]. Ballistic 2.0 was built based on the existing theoretical underpinnings from knowledge management and lessons learned research fields. The Ballistic model adds to the extant literature by integrating concepts from different fields to try to improve LL in project management. Corley and Gioia [37] also suggest that researchers describe the scientific and practical utility of a research explicitly. Ballistic 2.0 is scientifically useful as it addresses the relationships between knowledge management, LL processes and project management phases.

Ballistic 2.0 also emphasizes the importance of human interaction in knowledge creation. As people perform their activities, they create their own knowledge. But communication interferences can prevent people from sharing their knowledge with others [46]. Therefore, LL processes should facilitate human interaction and knowledge sharing as much as possible. Moreover, it also shows how LL management can be supported by Web 2.0 technologies.

5.2 Practical implications

It is time to stop making the old mistakes of performing the management of LL only at the end or after the project. Based on Web 2.0 technologies, Ballistic 2.0 supports explicit and implicit knowledge sharing in all phases of project management life cycle. Moreover, all LL processes included in Ballistic 2.0 can be applied in all phases of project management life cycle.

As there are no more reasons to neglect the insertion of Web 2.0 in Project Management activities, practitioners should start to apply modern technologies such as Twitter and WhatsApp to support the management of LL. Users should be guided to use hashtags to facilitate search and dissemination in Twitter. Additionally, Ballistic 2.0 can be used by practitioners to deal with common problems in project settings, such as loosely defined questions and free flow templates [38]. The Ballistic 2.0 model provides alternatives to solve these problems, such as using labels in wiki pages or using web-based documents to structure answers to asked questions. Finally, the Ballistic 2.0 model gives project managers alternatives to foster knowledge creation [25] and to create an environment for high-performance project teams [48].

6. Conclusion

This paper addresses one of the most complex issues in contemporary project management practice by introducing a model to manage LL in PMBoK process groups. The Ballistic 2.0 model intends to fill a gap in literature, which is the lack of a theoretical model on LL. This model is not only supported by existing literature, but also improves consolidated LL processes as it adds Web 2.0 technologies. Therefore, Ballistic 2.0 is in tune with Project Management 2.0, encouraging project managers to introduce emergent technologies in their routine.

One limitation of this research is that the Ballistic 2.0 model needs to be refined and assessed in empirical research. To do this, it is necessary to implement the model in organizations and to analyze the results of its use in practice. For future works, we intend to conduct case studies to validate the model qualitatively as well as doing research on management of LL in other PMMs.

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Adoption of web-based group decision support systems: experiences from the field and future developments

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Adoption of web-based group decision support systems: experiences from the field and future developments

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Abstract:
While organizations have massively adopted enterprise information systems to support business processes, business meetings in which key decisions are made about products, services and processes, are usually held without much support of information systems. This is remarkable as group decision support systems (GDSS) seems to fit for this purpose. They have existed for decades and modern versions benefit of web-based technologies, enabling low cost any-place, any time and device independent meeting support. In this exploratory case research, we study nine organizations in four different adoption categories to learn more about the reasons for the relatively slow adoption of web-based GDSS. Using the Fit-Viability adoption framework we conduct interviews with organizations that have experience with using GDSS. We conclude that adopting GDSS requires considerable and carefully planned change of processes that are deeply grounded in the organization. Existing meeting routines need to be adapted. Introduction needs to be carefully planned and room for face-to-face meetings and creativity sessions away from the keyboard need to be built in depending on the type of meeting. Not all companies find the cost level affordable. Clear and convincing business cases are lacking. Still the added value is ranked highly and there are frequent and enthusiastic user organizations that may lead the way for others. Their success stories show others how to mitigate problems.

Keywords:
adoption; implementation; group decision support systems; collaboration; meeting support systems; GDSS.

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1. Introduction

While enterprise information systems have been implemented by virtually all modern businesses, the adoption of automatic support for group decisions has lagged behind. Commonly, information from enterprise systems serves as input to business meetings, but the meeting itself is still held with very limited or no support of information systems. Around the world, on an average day, millions of such meetings are being held. Studies indicate that considerable time is wasted in these meetings, estimating 35% [1] to even over 50% of lost resources [2]. Research into effectiveness of meetings show that employees appreciate meetings with a clear structure and meetings that accomplish something meaningful and do not look forward to meetings that are unstructured, start late and do not lead to results [3]. Group Decision Support Systems (GDSS) seem to address exactly what is needed to have effective meetings, promising to provide structure, effective information exchange, idea generation and organization and support for effective decision making, even if participations cannot be present on-site. So why most meetings still are held without support of a GDSS?

1.1 Evolution of Group Decision Support Systems

Several studies have addressed this question and we will review exemplar studies and survey the results of systematic reviews in this area. However, it is important to realize that most of these works deal with earlier generations of GDSS. The current generation of GDSS, by making use of Web based collaboration and Software as a Service concepts, seems to substantially lower several known barriers to GDSS adoption. The emergence of these new GDSS are the key motivation for our study.

Watson et al. [4] describe a GDSS as a combination of computer, communication and decision support technologies to support problem formulation and solution in group meetings. They define the goal of a GDSS, based on many sources, as to reduce process loss. Process losses are all interactions within the group that slow down the process of making a decision. These include disorganized activities, dominant members and social pressure. Using a GDSS enables a clear structure in the decision making process. It supports to generate, clarify, organize, reduce and evaluate ideas. The structuring often helps to make the decision making process more efficient and effective and delivers an added value for the organization [5].

A traditional GDSS session is done with all participants in one room. Ideally, everyone is sitting at a table in a meeting setup. All of the participants have a computer in front of them which is used during various stages of the session. The session is led by two people. The first one is the technical facilitator. She/he makes sure all technical issues are taken care of. His job is to answer question from participants regarding their personal systems, operating the main system during the session and process all input from the meeting into the system. The session itself is led by a process facilitator. S/he plans the session and is the leader during the session. Her/his role is to make sure the group is progressing through all the phases in a rigid and sound manner.

The session starts with an opening statement by the process facilitator. The goals and plans for the session are explained and, if necessary, an introduction to the GDSS is given. A typical session then starts according to the funnel model (see Fig. 1). This model shows how the answers are processed by the group through consecutive phases. As the meeting progresses, the number of ideas is decreased through categorization and prioritization, while, if done correctly, the consensus within the group increases [4], [6].

The first phase is the Inventory phase. In this phase every participant is asked to input his ideas into the system. This can be done freely and without any obstacles. During the Categorization phase the facilitator takes the lead. The participants are asked to neglect their systems for a moment and join the group conversation. All input is shown and guided by the facilitator while the group categorizes the input. This means doubles are taken out and more or less the same answers are combined in to one. This process is mainly performed to make the next phase easier.

In the next phase, the Prioritization phase, the undoubled ideas are prioritized by the participants. How this is done differs per session, but these techniques include ranking and scoring of items. This is done by every user individually and when they are finished the results are consolidated. The aggregated result is presented by the system as the suggested decision. Naturally, it is not the objective of a GDSS to automate decision making itself. A GDSS only provides the participants with an objective presentation of their opinions. The final decisions however should have a broad support in the group, because of the process arriving at the ultimate outcome.

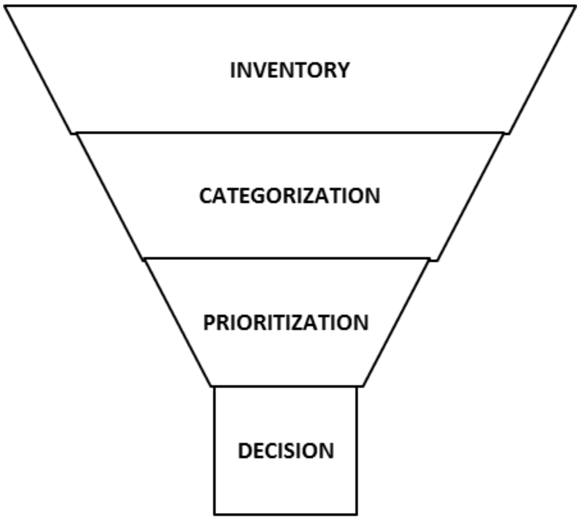

Fig. 1. The funnel model

During all phases of the session, the facilitator can make several choices. The first choice is if and when to show the given input on the big screen in the front of the meeting room. The answers can be shown during, e.g. the inventory phase, in order to inspire others for new ideas. Also it might help to reduce the number of double inputs for the next phase. An argument for not showing the ideas on the screen is to ensure a tunnel vision is avoided.

The second decision that needs to be made, is whether or not to show the names of the different authors. Showing the name makes it impossible to hide from personal input. This makes participants think about the quality of their input. However not showing the names eliminates the political games that may be going on within the group. An idea provided by a manager might be scored better, just because of the author, as people might be afraid to be critical [7].

The session described above is the most basic session that can be held with a GDSS. The software is capable of supporting various ways of working. The example session is an example of a same place, same time session. However by use of the phased approach and the internet, new opportunities arise. The same session structure can be maintained in a different place, same time structure. This requires, besides an interface with the system, a video or audio connection with the other location. This allows for example global team to make use of the system. However, in some cases it might be hard to collect the complete group at the same moment. When this is the case, an asynchronous session can be organized. In an asynchronous session, the facilitator sets up the first phase and invites all participant to collect their ideas into the system. The participant can do this wherever they want; at a set place (same place, different time) or at a place of their liking (different place, different time). When everyone has completed the first phase, the facilitator checks the results and initiates the next phase. This continues until the process is finished.

1.2 Studies into adoption of GDSS

De Vreede et al. [8] review some GDSS field studies and their findings. These report largely positive experiences such as higher perceived and measured meeting effectiveness and efficiency, improved meeting outcome quality, high participant satisfaction. However, also a lack of increased performance was reported. Some organizations reported abandonment of the GDSS due to a lack of frequent use. Also, too little support for debating and negotiations was observed by some adopting groups. De Vreede et al. [8] in their own field studies confirm the usefulness of GDSS features such as anonymity and parallel communication. They conclude however that more longitudinal research is needed to get better insight in the diffusion and success over longer periods of time. Also, they recognize that the computer technology and GDSS in particular continues to change dramatically, partly making results of earlier studies less significant. Fjermestad and Hiltz [5] evaluated 54 case and field studies and concluded that there are several elements contributing to the successfulness of a GDSS implementation. The use of a facilitator (the session leader), the number of sessions, the amount of training and kind of tasks performed are found important. Still, limited adoption and failures of GDSS use have been reported [9]. The authors find that improperly designed GDSS sessions, technology breakdowns, unskilled participants or facilitators are frequent causes of such failures.

Today, more than a decade later, for most professionals it is still exceptional to be part of a meeting that is supported by a GDSS. While the use of Internet, mobile technologies and social media have become commonplace, GDSS remains a rare commodity. Modern GDSS have benefitted from advances in hardware, software and network technologies. They now typically run on various devices using web-browsers as their platform in a Software as a Service (SAAS) delivery model. Sessions and data are stored in the cloud allowing participants to take part in a meeting any place, anytime. New devices such as smart phones and tablets have been massively adopted and allow virtually any knowledge worker to use a GDSS. While there are many, partly free, tools on the web that provide part of the typical GDSS functionality, full featured GDSSs continue to be the domain of a limited set of specialized vendors. A GDSS provides a comprehensive set of functions to support all phases of a meeting. The participants are taken through the inventory stage to the categorizing and prioritizing stage, the so-called funnel model. This ultimately leads to a decision by the group.

This paper aims to address the question why still so many meeting are held without a GDSS. More than 30 years after the developments of the early GDSSs, the technology seems mature. Why is the adoption of GDSS by organizations so low? What can organizations the plan to adopt GDSS learn from current experiences? The next section introduces the adoption model we use in this study. Then, we explain our research method, the results from the case studies are shown and conclusions presented.

1.3 Models for GDSS adoption

Several models can be found in the information systems literature to study the adoption of GDSS. DeLone and McLean view systems, information and service quality as key variables that impact intended use, use and user satisfaction and ultimately net benefits to the organization [10],[11]. The Unified Theory of Acceptance and Use of Technology (UTAUT) combines elements of several theories and researches on the adoption of information systems by individuals. The UTAUT model makes a distinction between four key constructs for the behavioral intention and use: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions. Both the expectancies are about the beliefs of the user that use of the software will help her/him in the job and the belief of being able to use the software without a big effort. Social influence is the degree to which an individual perceives that important others believe he or she should use the new system [12]. These constructs however are not equally important for every user. There are four variables influencing the impact of each construct: Gender; Age; Experience; and Voluntariness of use. Not all variables effect each construct, as can be seen in the UTAUT model.

The classic Diffusion of Innovations work by Rogers is also relevant to the adoption of GDSS. Rogers defines five stages in the Innovation-Decision Process [13]. In the first stage the individual has been exposed to the innovation, but does not take action to learn more about the innovation. In the next stage s/he starts to get interested and actively seeks for more information. When enough information is gathered, the third stage is entered and the individual decides whether to adopt the innovation or reject it. In the next stage the innovation is used in some way and judged for its usefulness. In the last stage the decision is finalized. Looking from a higher level several types of users can be distinguished, each in a certain state of maturity. In the curve the level of adoption is plotted against time. Each of these user groups has its own needs and wishes. The GDSS software as it is used now, is located in the innovator or early adopter phase. This means the level of adoption is still low and it has only been adopted by organizations who are willing to try this new innovation (take a risk).

A recent framework tailored to studying the adoption of the newest generation of collaboration tools (so called Collaboration 2.0) is developed by Turban et al. [14]. They combine elements from several adoption theories and integrate them into a framework to study the adoption of Collaboration 2.0 tools, aimed at group decision making. According to the authors the ease of use of current tools is higher and costs of use are much lower than their predecessors. Web-based collaboration tools offer more interaction and flexibility. They state that adoption of GDSS is based on two things: Fit and Viability (Fig. 2). The Fit component focuses on the firm's needs, core competencies, structure, value and culture of the organization. The decision making tasks and nature of the group are "checked" against the chosen tool, in our case a GDSS. The Viability part consists of three elements; First, the financial element, where costs for maintenance, training and acquisition have to be compared to the value of the tool for the organization. Second, the IT infrastructure is an important element. This involves all infrastructures necessary for running the software, for example, server configurations and security upgrades. In case of a GDSS there is an option of using the supplier's servers for hosting the session. This considerably lowers the requirements for infrastructure. Third, viability to the organization is a relevant element. The users need to see the benefits of the software for their tasks. The fit can occur, but it has to be acknowledged and be observable and measurable.

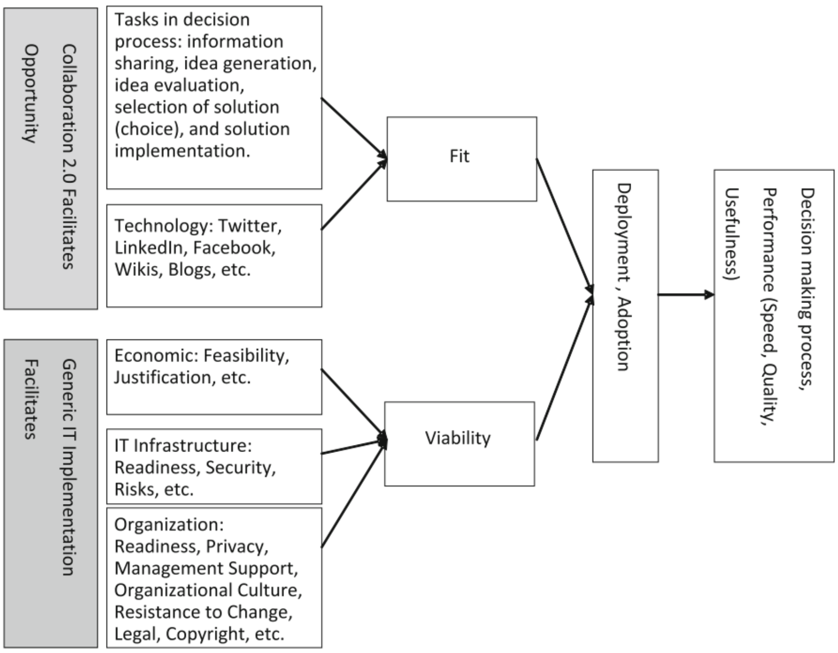

Fig. 1: A Framework for Adopting Social Networking Software for group decision support [14]

The remainder of this paper is structured as follows. We first present our research method. Next, we present and discuss the results for various groups of GDSS users. Finally, we present technology developments that will have an impact on GDSS and its adoption and give our conclusions and limitations of the study.

2. Research method

In this research the Fit-Viability theory discussed in the previous section is used. It is very suitable for this research as it lists a wide range of explanatory factors so that the cause of adoption or non-adoption can be explored taking a broad viewpoint. Moreover, it is explicitly designed for studying the adoption of collaboration 2.0 tools, a category to which modern GDSS belong. In order to reveal the reasons for not adopting GDSS on a larger scale, we conduct a number of case studies using the following steps. First, criteria for participating companies were set for each of four groups. The first group is the group of frequent GDSS users. The second group are non-frequent users. These users are seeing the benefits of using a GDSS, but are not using it very often. The third group acquired a GDSS, but stopped using it. The final group had a demo session with a GDSS, but decided not to buy one. An interview guide was created consisting of a protocol and semi-structured questions. Next, companies in each of the four groups were invited to participate in the research, interviews were held and analyzed. To make sure the research would not only show the flaws in a certain GDSS, the users of two different GDSS systems were interviewed: Spilter and Group Support. These two companies are responsible for about 90% of the Dutch GDSS-market. An adopting organization was interviewed from each group and for each of the two GDSSs. There are thus two results in each category of organizations. In the low adoption group, three organizations were interviewed, which brings the total to nine case companies.

The first step of the research was to select case companies. It was decided to invite companies from various industry sectors. GDSS vendors Spilter and GroupSupport each provided a sample group. The first part of the interview was aimed at gathering knowledge about the interviewee. The following questions were included:

- What is your function and what tasks are you performing?
- What experience do you have in using GDSS?
- In what kind of meeting are you using the GDSS and what role and rank do the participants have (e.g. board member, manager or operator)?
- How did you get interested in GDSS? (Non-user question)
- What did the decision process to acquire a GDSS look like? (Current and ex-user question)

In the next part of the interview the Fit component was discussed. Firstly the fit between the task and tool was explicitly discussed: What are the benefits of using a GDSS and where does the tool not comply with the task? Also the participant was asked for the perceived value of the tool. Does the tool accelerate the decision making process and is the quality of the decisions any better using the GDSS? At the end of this section the participant is asked if he/she perceives that the GDSS has added value and if a "normal" session or a session with a GDSS is preferred when given the choice.

The third section of the interview is about the Viability branch of the Fit-Viability model. First the financial cost-benefit analysis is made. What costs does the GDSS imply and what benefits does it entail? Next, it is interesting to know if the participant believes these benefits are greater than the costs. Then the organizational readiness was reviewed. Possible IT problems were identified. Was there any new hardware needed for using the system and was the organization technically ready for the new system? Besides this the participant was asked if he/she believes the use of the system is problematic for his/her colleagues. Next, the implementation was discussed: What implementation strategy did you use and what problems came up during the implementation process? If there were any problems, more details about their nature and impact was asked, and how the problems were addressed. For the non-GDSS users there was one last question: Why did you decide not to purchase a GDSS? Also, the ex-users were asked why they decided to stop using the system.

At the end of both the Fit and Viability part, a series of propositions was used to verify our analysis of the answers to the interview questions. These propositions revisited the topics that were touched in the interview questions before and made it possible for the interviewer to check his interpretation of the answers. The interviewee was asked to rate a certain proposition from 1 to 5, 1 meaning "completely disagree" and 5 "completely agree". This way miscommunication could be detected earlier. If, for example, the interviewee used the word “great”, this could have a completely different value to the interviewee than to the interviewer. The interviews were conducted and analyzed from the end of 2012 to early 2013.

3. Results

This section summarizes the results of the interviews. Each summary starts with a short description of the participant and her/his working environment. Then the outcome of the interview is presented.

3.1 Frequent users

Participant1 is employed at a large consultancy firm. Her first experience with the system was while working on an assignment as a consultant. The business now provides about 35 sessions per year. Roughly four kinds of sessions can be distinguished: creative sessions; strategic sessions; risk assessment; and “create order”. These sessions are mainly attended by highly ranked managers discussing tough issues. In this situation the use of a GDSS provides several benefits. The system very clearly shows what has been discussed and shows those subjects which need further discussion. “Accelerate where possible, to decelerate where you have to”. This leads to better consensus, which leads to more support towards the outcome of the session. But there are some concerns. During the session the role of the facilitator is crucial. The facilitator has to decide what the desired outcome is and what questions need to be asked to gather them. This leads to a more carefully prepared meeting and better outcome. It is also important to realize that the tool is not the only option in the world. Sometimes it is better to take another approach to solve the issue. This is something the facilitator has to assess. During the session it is important that the facilitator makes sure everyone goes along with the session. The suggestion that maybe key positions in the organization might be occupied by the kind of managers that need the traditional model is denied instantly. If the manager would not want to know the opinion of his employees, there would not be a session. There are some other causes that lead to resistance. The use of new technology always makes people anxious. Also the use of a computer or tablet can be distracting and the transition from a verbal discussion to electronic voting can be a bit unnatural sometimes. Looking at the costs there are license costs, write-off on the used hardware and the costs for the facilitator and the coordination. These costs are compensated by several benefits. Use of this tool allows for more branding and it even brings new customers to the company. This advantage is largest in cases where many stakeholders are involved. “It is a nice and effective way of meeting”.

Participant2 is also working for a consultancy firm. He has a lot of experience in the use of GDSS. His first experience with a GDSS was during his study at Delft University. As a student assistant he was responsible for the technical support of the session. Later on he became a facilitator and did lots of research on the success and quality measuring of GDSS sessions. Nowadays he is working as a consultant and also as the project manager for the GDSS. In this role he tries to “sell” the GDSS to his colleagues and get them ready for taking the tool to their clients. The system is used two to three times per month. Use of the system really speeds up the decision process. He finds that the easier voting and possibility to work simultaneously really speed up the process. But the biggest advantage is that use of the system forces you to prepare the session more extensively. Participants in the sessions like the fact that the session enforces a certain structure which is clear from the beginning. This does not mean that everything has to be done in the system. There still has to be a human contact, the system is just an aid in getting to the desired outcome. “I always try to make a 50-50 diversion between using the system and discussion. Otherwise people could just have stayed at home”. According to the participant this is one of the major problems for the system. People think that use of the system eliminates all contact during a meeting, but in a properly organized meeting this is surely not the case. Besides this there are some other issues. Use of technology in general scares people, so it is hard to build any trust in the system. If a person has one bad experience using the system, all trust is gone and can hardly be restored. But most of all it is hard to accomplish the needed mind shift. People have been working in a certain way for a long time and changing this is really hard. Preparation takes more time and some specific process skills are required. The facilitator has to sense the group and lead them through the process. This scares away people. Within the company two portable sets are used to host sessions. This gives two additional obstacles: transportation costs and the need for a second person to do technical support.

3.2 Less frequent users

Participant3 is working at a special unit within the Dutch government. This unit has resources for hosting a session, of which the GDSS is one. The participant is a technical facilitator. He is involved in all technology used by the unit. The sessions in which the GDSS is used are very diverse. A great benefit is that everything is recorded and shown to the group immediately. Meetings go faster and better and also more ideas are produced. Although this participant is an experienced and enthusiastic user, he does not always prefer to use the system over a whiteboard session. Which method is used depends on the session. “To have someone working with the system all day is not always good”. This is probably why the system causes almost no trouble: it is only used when it’s beneficial.

Participant4 is employed at a large Dutch telecom provider. Until recently he was working as a consultant for companies outsourcing towards his company. From that point he started working on optimization of the decision and internal processes. At the moment the GDSS system is used for internal and client meetings. The participant is working as a facilitator. After a few sessions people got enthusiastic by the enormous productivity boost. “If properly applied, it can lead to an efficiency gain of 75%”. This reduces both costs and time needed. People feel the need to make their statement. This need becomes bigger as they become higher in the organization. Normally this takes a lot of time, but using the system they can do this simultaneously. During sessions the role of the facilitator is crucial. There is a small amount of meetings that follow the prepared agenda, but most meetings do not. In these sessions opinions can be so far apart that preparing is not possible. According to this participant there are several possibilities why this tool does not make it to the big public. The tool should be presented in the right way at the right time. Here the role of the facilitator comes in again. The facilitator has to feel what the group wants. Sometimes it can be useful to split up and work in separate groups or just take a break. People are scared that use of this technology will take away the human interaction. For some reason technology is seen as something individual. Finally a mind shift is needed. People can no longer make a point based on verbal skills. This might even ask for another kind of manager.

Participant5 is working at an IT-consultancy firm. As a consultant he specialized in education. His first experience with a GDSS was as a participant. He was very enthusiastic right away and saw the possibilities the system offered. Now he has worked a lot with the system, but within the company he is now employed they do not use such a system. The participant is now trying to work it in to the company so that his colleagues can add it to their toolbox. This process is not going very fast. The past year he tried to slide in the system at several occasions, but every time people are slowing down and rejecting the offer. There is a fear that creativity will be lost when using the system. That's why he tried a combined session of flip over idea generation and ranking and scoring using the GDSS. Reactions to the demos are pretty positive, but eventually nothing happens. Benefits of the system can be found in a quick insight in results and automatically generated reports. It also gives an innovative image to the company and creates an advantage with respect to the competition. Clients see the system as positive and refreshing, participants in a session enjoy doing it. The main reason for the lack of adoption is the prejudices. People are afraid of working with technology and changing their habits. “Going on as it is done now provides more security and takes less time than trying something new”. Deploying a GDSS does both.

3.3 Former users

Participant6 is employed at a big transport hub in the Netherlands. In particular the brainstorm sessions went much better with use of the system. A great benefit is the fact that no one can put his stamp on a meeting. Rank or status no longer counts, every idea has the same value. An idea gets judged by its value and not by its creator. Also the parallel working speeds up the meetings a lot. If everybody shows commitment to the system it has a great benefit in time and quality. But people value the conversation very much, so they are scared that it will disappear. The participant endorses that this sometimes happens, but also thinks that it creates a little time to think and that it is partly compensated by the possibility to see each other’s answers. A major problem is the lack of integration with the rest of the systems. It is not possible to integrate Microsoft Office documents in the session. This is something the training really needs. This was now done by changing screen, but people found that annoying to do. Besides this reason, there are two other reasons for the exit of the GDSS. The first one is financial. Now it is no longer used in training, the costs per use became too high. The other reason is political. The incident control team is a combined force of several agencies, of which the Dutch government is one. They decided to use another system, so the use of the GDSS drops even further. When a good alternative, part of the Microsoft office package, came alone, they started to use that.

Participant7 used to work at the R&D department of one of the GDSS vendors. Then he transferred to a starting *spinoff* related to a Dutch university. The spinoff used this system from the start, mostly doing "normal" sessions. According to this participant, especially the converging tools are very strong. The diverging, collection of ideas, can be done by other tools as well. The system created a time improvement through parallel working. Deployment of the system generated new clients and made them come back. People experienced the timesaving and found it fun to work with the systems. Whether the systems created a quality boost is not sure to the participant. He never did the same session twice, so he finds it hard to compare it to a brown paper session. This participant also emphasizes that the facilitator plays a very important role. The facilitator needs a lot of experience using the system as well as hosting sessions. This is according to the participant the main problem for adopting a GDSS: it is facilitator driven. The need of a special facilitator combined with the extra preparations create a problem for easy adoption. "It really is a tool for consultants". The reason for stopping had nothing to do with the GDSS itself. As the business was stopped, so was the use of GDSS.

3.4 Non-users

Participant8 is employed at large insurance company. Within this company there is a special unit hosting all kinds of workshops. He is responsible for this unit and is also an active facilitator. In this workshop center there are several options for hosting a session; there is a room completely covered with whiteboards, but also music, movies and creative materials (e.g. paint and Lego) are used. The intention of the research was to find out if a GDSS could be an addition to the current options for hosting a session. She is convinced that under certain circumstances the system could function very well. In her job she looks over all incoming request and assesses if a session in her center is the right way to go. Most of the time the target is to create support or to speed up a certain process, but a joint session also generates more ideas than when everybody is working on his own. According to the participant the tool fits its task very well. The system could be very well used in the inventory and clustering phase, maybe also for the first step of prioritizing or voting. It would be very important that people stay verbally connected. Everybody should share and explain their preferences. An advantage during the inventory phase is that this can be done asynchronous. This saves time, as does the automated report function. This timesaving directly creates a financial win, this because the session time is reduced. The anonymity given by the system will possibly lead to a higher output because people feel freer to present their ideas. Whether his would create a quality improvement is not sure to the participant. Some people like focusing on their laptop, others just do not like this. The final decision to not purchase the GDSS was based on the financial aspect. In this time of economic crisis every purchase is assessed very carefully. Although the system could give a new boost to the unit, the license cost and the costs for additional hardware were too high. There was also a personal motive. Being allowed to use a tool like this involves a bureaucratic process which requires a lot of time and energy, which were not available. Besides this the participant found it frightening to change all her working processes.

Participant9 is working as a staff member at an education group. As part of his job he is responsible for making a year plan involving many subjects and shareholders. The participant had attended a workshop in which a GDSS was used. The tool fitted this task perfectly, determining the structure and content of the sessions was harder. Use of the tool would be no problem for the specialists and experts, but there´s also a group that would rather not use the tool. This is because the tool provides much more transparency and makes people more aware of content. People who are now defending their self-interest will not like this. And if these are the people guarding the money, the system will not be introduced. Now this was not the case, it was a timing issue. The project in which the GDSS should be introduced was connected to another project. This had already started and fixed several points in the plan. So with the project partly established the introduction of the tool was postponed. It was postponed because the participant does see several benefits in using the system. Experts and specialist often feel unheard and see the system as a great platform for their points and ideas. The automated reports are also a benefit. In these reports nothing goes lost and the systems creates them very fast.

3.5 Propositions

As mentioned before, interviewees were asked to give their rating on a set of nine propositions. The scores were used to verify the interpretation of the given answers. Although these scores do not enable any quantitative analysis, they present a result that matches the qualitative analysis above. The used statements are the following:

1. The tool fits well with the job I want it accomplish.
2. The tool is user-friendly.
3. The quality of my decisions is better with the use of a GDSS.
4. With the use of a GDSS my decision speed is higher.
5. Purchasing the system is affordable.
6. Use of the system does not require any specialties in the field of IT.
7. The system is for participants, after a short instruction, quickly usable.
8. The implementation of the system went effortlessly.
9. Use of a GDSS in total is an added value for my business.

In Fig. 2 the mean scores for each proposition are given and the extreme values. Because the non-users were unable to score some of the propositions, the n-value of five of them is 7 instead of 9. It can be seen that all scores are relatively high. This suggests that all participants are pretty positive about the use of GDSS. There are two scores that need an explanation. The first one is the 1 given by one of the participants for the affordability. This participant, *Participant6*, thinks that the license costs are pretty high, especially when calculated per use. This is one of the reasons they stopped using the system, so he scored this 1. The second one is the 2 scored by *Participant8* for specialties in the field of IT. This score was given because for the use of the system a set of laptops needed to be purchased and the GDSS needed to be accepted in the current IT environment. So this was rated insufficient, but fits with the answer given.

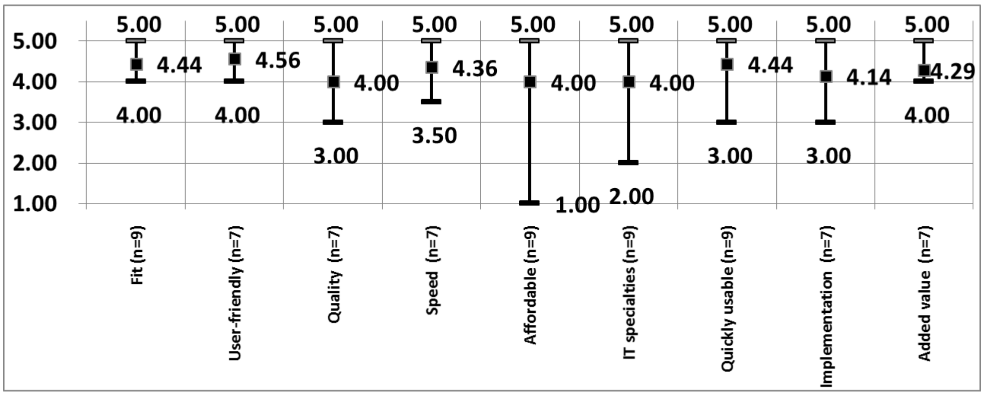

Fig. 2 : Scores by Interviewees on the Propositions

4. Discussion

4.1 Factors slowing down the adoption

Looking back at the results, some possible explanations for the low adoption of GDSS can be found. The first one is fear, especially the fear of change. The interviewees suggested that people seem to be scared to put their current methods aside and start using the GDSS. The current meeting culture allows people to participate in a meeting a bit more relaxed. Their discussing the matters at hand over a cup of coffee. Now the meeting is a lot more structured and requires more attention from the participants. Also the chair of the meeting needs to put in a lot more effort in preparing the meeting than "just put together an agenda". Executing a successful GDSS session asks for changes in the way people work now. This is a part of the working culture and is not easily changed.

Another possible explanation can be found by the early adopters. As mentioned by three participants, an enthusiastic adopter might try to use the tool in every occasion, even were it is not suited to use it. An important part of preparing the session is to select the most suitable work form to achieve results. This sometimes might mean the GDSS has to be put a set. Especially when the system is newly introduced, it is crucial to select the proper meeting for displaying the system. Trust in the system is hard to build, but very easily destroyed. *Participant4* even suggested that the overenthusiastic adopter might scare people away. He suggested the same thing as could be seen at Apple iPhones. Owners of an iPhone telling all the time how great their phone is, made other people dislike the phone. Not because of the product, but because of their feelings.

The GDSS is mentioned to be perfect for running a brainstorm session. At the same time many people believe that working with the system disturbs the creative process. Three participants mentioned that the switching between the creative thinking and working with the computer might be a problem. Working with the system requires a structured and systematic way of thinking, whereas the brainstorm tries to provoke an unstructured, loose way of thinking.

There also is the fear of losing the dialogue during the meeting. This is a real concern in using the system. As people are sitting behind a screen, it is very easy to hide from conversation. This requires extra attention from the session leader, by choosing suitable work forms to keep the group communicative, and from the participants themselves. Being aware of this problem, they can keep themselves and others from doing this.

Another obstacle in the adoption of GDSS is the economic crisis. At the moment many companies are only investing in things that are necessary for their business or have an immediate effect on their profit. A GDSS is neither of them. It can improve the internal meetings by supporting faster and better quality decisions. The deployment of a GDSS in a consulting setting might also be an advantage in winning orders. However, these are all indirect benefits from the GDSS. From a business view, the system has no necessity (meetings can be held without it) and the benefits are indirect. This might be an explanation for businesses not taken the leap.

Finally, one last explanation was found. It was noted that almost all interviewees mentioned that the system is seen as innovative, refreshing and a nice new way of working. This is kind of a surprising typology of the GDSS as it is a technology which exists for almost 30 years. This might indicate that the system has a problem with its publicity. This could implicate that the system, besides its above mentioned obstacles, is not well known enough by the right people.

4.2 Key to success

All nine participants mentioned the role of the facilitator to be very important, if not most important to the adoption of GDSS. The importance of the facilitator can be found in every aspect of GDSS use. It start by selecting the right session and the right group of participants. As mentioned before, some combinations could better be avoided depending on the familiarity with GDSS.

In the preparation of the session, together with the one responsible for the content, the facilitator needs to make a good plan. Which options and techniques of the system need to be used in order to get the optimal result. This is also the main objective during the session. The facilitator has to work with the group intensively in order to have them perform optimally.

5. A look into the future

As we observed earlier, computing and network technologies in general, and GDSS in particular, continue to evolve rapidly. In addition, users slowly become more proficient in using advanced software systems. Hardware devices with built in touch screens, webcams, wireless connectivity and ample processing power have become ubiquitous. Intelligent software applications increasingly succeed in using artificial intelligence techniques to support expert users. These technologies will continue to impact GDSS and its success and diffusion. Research as presented in this paper therefore is in need of continuous replication and extension. In our view after three decades of GDSS we are still only at the beginning of the ride. Below, without claiming to be exhaustive, we highlight a few of these developments.

5.1 Enhancing the user interface

GDSS vendors have been struggling with the tradeoff between feature richness and ease of use. GDSS are currently being extended with smarter user interfaces that offer various modes of usage (beginner, expert) or adapt intelligently to the skill level of the user.

One of the vendors engaged in this research recently launched a new session form. This type of session, called the hybrid form, tries to make a connection between the digital tool and an offline session. This is done altering the structure of the session after the inventory phase. In this work form, the collected ideas are printed onto stickers which are marked with a QR-code. The ideas then are processed offline, just like in a regular brown paper session. When all sorting and prioritizing is done, the session leader uses a special app to scan all the answers and the place, including the group they are sorted to. The session can then continue as normal. This solution copes with the problem people tend to have with working digitally. By using this offline techniques, people should feel more comfortable in working with the system.

At the same time, new devices such as large sized multi user touch screens and touch tables at affordable prices open up a whole new area of possibilities for GDSS. New devices such as the Oculus Rift or may enable a whole new class of GDSS that enable distributed collaboration [15]. Mobile robotic telepresence (MRP) systems incorporate video conferencing equipment onto mobile robot devices which can be steered from remote locations [16]. MRP can further enhance the virtual presence of members taking part in a remote meeting, e.g. by allowing them to ‘walk’ around and talk to participants that are physically present.

5.2 Facilitator as a Service

Another idea is Facilitator-as-a-Service. The lack of a skilled facilitator is often hindering GDSS success. As Kolfschoten et al. [17] describe: “Skilled facilitators, however, tend to be expensive. They either have to be trained in-house, or hired as external consultants. Therefore many teams who could benefit from facilitation interventions and from GDSS must often manage without them”. Both the provided options are quite expensive. Therefore businesses may profit from a service based facilitator. The facilitator as a service might be present in a session using a video conferencing method. This makes skilled professionals from all over the world available to all companies. By using a teleconferencing tool, the facilitator saves travel time and costs, which also allows for lowering the fees as the facilitator can do more sessions per day. This idea also suits the asynchronous sessions very well.

Providing more companies with easily accessible facilitators might very well help the system to become more popular. As stated before, the facilitator is one of the most important factors in a GDSS session. Having companies see the added value provided by the system, will probably help the system in becoming more known and used.

5.3 Intelligent software assistance

Currently, especially in sessions with larger group sizes, the clustering of ideas can be labor intensive. Researchers are currently experimenting with automatic cluster algorithms that could relief the group and facilitator partly from this task by presenting various clustered idea sets [18].

Another drawback of the current generation of GDSS is the lack of support for negotiation. A separate class of specialized systems is being developed addressing this issue. In future versions, negotiation support could be integrated in the GDSS [19].

As the facilitator role is critical but required skilled and scarce resources, the knowledge required could be captured and partly automated. The thinklet concept has been proposed and is similar to design patterns. It offers parameterized action representation of transferable, reusable, and predictable building blocks for the design of a collaboration process [20]. Based on successful thinklets, facilitation support systems could be integrated in GDSS to further enhance the collaboration.

Finally, smart integration of social media into GDSS seems a promising direction. The availability of social media can enhance the group decision process by both integrating social media functionality and platforms into GDSS. The rise of social media tools and techniques has also accelerated the development of new tools such as sentiment and opinion mining algorithms [21]. These can also find their way to GDSS to enhance their functionality.

6. Conclusions

We used the Fit-Viability model to study adoption of GDSS in various organizations. This model provides a lens to study the GDSS adoption phenomena rather that a basis for quantitative explanatory analysis. As such, it was a good fit to the purpose of our study. The results show that several factors play a role and often the 'story' behind the success of GDSS in an organization seems more important than the precise evaluation of the meeting productivity or GDSS business case as the data for making such assessments is missing.

The fit of the task to the GDSS needs to be checked before deploying the GDSS. This is an important task for the facilitator. In the Viability part there are several factors that explain the currently low adoption. As GDSS have no proven effect on results, there is no drive to purchase one. This also influences the IT Infrastructure part, as some of the participants had to buy IT hardware to run the system. Also there are some possible explanations linked to the Organizational factors in the model, mainly the Readiness and the Organizational Culture.

Based on these results, some lessons for the newly adopting businesses could be drawn. As stated before, the facilitator is very important in the use of a GDSS. The costs and effort needed to train someone for this job are a crucial investment for the success of a GDSS. The process of trust building is guided by this person. Picking the right meetings and people for the early sessions creates support for the system and its capabilities. We have reviewed several promising developments in GDSS in three categories: (1) Enhancing the user interface; (2) Facilitator as a Service; and (3) Intelligent software assistance. As these technologies mature the GDSS adoption landscape will continue to be impacted. Studies into adoption of GDSS will therefore continue to be relevant.

There are some limitations to this study. This research only studied organizations that are familiar with GDSS, being only a small subset of all full potential of adopting organizations as GDSS is still in the early adopter phase. Another remark is that this research is based on a relatively small sample of nine in depth case studies. When more organizations get involved in GDSS we aim to repeat this research using larger samples. Although it was not possible to get statistically significant results, many similarities can be found in the stories of the early adopters. Organizations that consider to adopt modern web-based GDSS may find the lessons learned in this study of useful to plan a balanced and successful introduction of these systems.

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Managing project interdependencies in IT/IS project portfolios: a review of managerial issues

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Managing project interdependencies in IT/IS project portfolios: a review of managerial issues

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Abstract:
Adequately managing project interdependencies among diverse and simultaneous projects is deemed critical for successful implementation of project portfolios. The challenge is significant because it may entail managing a complex network of project interdependencies that keeps changing over time. The present study investigates the managerial challenges that may undermine effective management of project interdependencies in IT/IS project portfolios. The investigation is based on evidence from reviewing relevant literature and documented studies associated with managing project interdependencies. The main contribution of this study is to discuss three managerial challenges of project interdependencies in project portfolios. We discuss the challenges from three perspectives: types of interdependencies; patterns of interaction in interdependencies; and cost/benefit impact of project interdependencies.

Keywords:
project portfolio management; project interdependencies; project interdependencies management; project management; IT projects; complexity.

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1. Introduction

Although there is much research available about inter-project dependencies, there are still many questions to be solved concerning how to handle these interdependencies. In this context, effective management of project interdependencies is deemed critical for successfully implemented project portfolios [1]–[6] especially under conditions of dynamic environment [7], [8] and increased uncertainties [9]. This implies the need of having a proper organizational arrangement to secure adequate control over the portfolio development cycle, and it also implies the need to maintain continuous coordination among various interdependent activities and tasks in the portfolio. Coordination, in this sense, is defined as "the act of managing interdependencies between activities performed to achieve a goal" [10, p. 361]. Considering this definition and the fact that every project portfolio is a goal driven endeavor [11], it can be realized that goals maintained by interdependent projects are naturally parts of an overall goal specified at the portfolio level. Consequently, any change in the portfolio goal will likely result in other project interdependencies being added, modified, or dropped. For instance, a sudden change in the portfolio goal (due to change in market conditions) may impact the priority and scope of some projects and to some extent may add or exclude some others. In effect, this may end in a situation where effectively managing interdependencies between relevant projects is needed for the portfolio to progress and perform efficiently. Under such circumstances, managing a large network of project interdependencies is more complex, difficult to control, and easy to get wrong [12]–[14]. Guo [15] supports this view by considering interdependency management a significant issue when software systems grow large in scale and complexity. Meantime, less attention to project interdependencies can result in a skewed portfolio direction leading away from the intended objectives of combining the projects [16]. The study aims to highlight the managerial issues concerning the management of project interdependencies between projects comprising an IT/IS project portfolio. The research question for this study is: What are the managerial challenges in managing project interdependencies as project interconnectedness is crucial for any IT/IS project portfolio to succeed?

2. Research method

To address the research question and to identify the possible obstacles that managers may face while managing a portfolio of IT/IS projects with multiple project interdependencies, it is important to first gain deeper knowledge in the following areas.

(1) The emerging need for project portfolio management;
(2) Project interdependencies and their subsequent characterization;
(3) Results from poor management of project interdependencies;
(4) Barriers to effective management of project interdependencies.

To advance our knowledge in the previously mentioned areas and to provide a comprehensive summary of the related literature, we have used Webster et al. [17] guiding principles for conducting the literature review. In the first search round, the Google Scholar search engine was used to identify articles that partially or thoroughly relate to the topic under investigation (i.e. project interdependency management within IT/IS project portfolio context). The search was conducted between the years 2000 and 2015 since there has been a significant improvement in the IT/IS sector during these years. In a similar vein, other contexts including program management and multi-project management, and new product/service development, were also investigated for their close similarity to project portfolio management. As one stream of the studies have used the term "interaction" as equivalent to the term "interdependency" (such as [14], [18], [19]), we considered the use of both terms during the search process. In this regard, we conducted the search using a combination of keywords including "inter-project dependency", "inter-project interdependency", "project interdependency", and "project interaction" together with their corresponding plural forms. Based on the first search round, we extended the search in the databases of International Journal of Project Management, Project Management Journal, and Association for Information Systems AIS Electronic Library, as these journals were a major source for the targeted articles. This has resulted in a total of 187 publications (i.e. research articles, books, and thesis works). After thoroughly reading through each study's abstraction and conclusion, 81 publications were excluded since only peer-reviewed articles were considered.

The article is structured as follows. In the third section, we present the concept of project portfolio management and its growing acceptance among IT-intensive organizations. In the forth section, we provide a closer view of project interdependencies including their types, patterns of interaction, benefits, and complexity considerations. The fifth section highlights the negative impacts of ineffective management of project interdependencies. In the sixth section, we highlight issues that might impede effective management of project interdependencies. Finally, we provide a comprehensive discussion of the potential role that project interdependencies can play in the performance of project portfolios.

3. An overview of project portfolio management

Nowadays, Information System and Technology (IS&T) projects dominate many industries and particularly those operating in high competitive markets such as new product/service development organizations with high-technology end-products. In such multi-project environments, the number of projects tends to be high, they hold similar characteristics, share common resources, and are greatly dependent [20]–[22]. Projects of this form are often assembled into group(s) or portfolio(s) of projects in which they tend to be closely coordinated and concurrently implemented to secure the ultimate goal by which they were selected and grouped. A project portfolio approach offers a holistic multilevel perspective on how projects can be effectively proposed, prioritized, combined, and later carried out to fulfill the organization's aim and purpose [23]. For instance, implementing a large Enterprise System (ES) (to improve the business competitiveness of an organization) may include multiple interrelated projects ranging from large-scale projects, like IT networking, IT security, and a possible combination of ERP, CRM, HRM, and SCM systems, to relatively small projects such as business intelligence and knowledge management applications. In carrying out such projects, organizations may find it practical to consider a portfolio approach for a better arrangement and synchronization of their projects. From a management perspective, implementing such a system would entail organization-wide involvement coupled with extensive efforts to manage a substantial number of project interactions that keep changing and increasing over time [4], [24]. The changes may, for instance, be due to unexpected external/internal conditions. Prior research on project portfolio management has considered interdependencies between projects a critical aspect in the planning and successful implementation of project portfolios [7], [14], [18], [25]–[27] paying much attention to interdependencies caused by simultaneous utilization of scarce resources [14], [19], [28], [29].

4. Project interdependencies within a project portfolio environment

In general, project interdependencies may exist when one project is partially or wholly being influenced by another project(s) for its development or, literally, when "the success of a project depends upon other project(s)" [2, p. 556]. Interdependencies between projects may occur at different project levels including tasks, objectives, alliance, and even at a project level as whole [25], [30], [31]. For instance, prior to commencing a task in Project A, another task in Project B has to be performed first. This form of serial relationship between the two tasks is recognized as sequential interdependence (Fig. 1, subsection 4.2) where one entity produces an output necessary for the progress of another entity [32]. Other forms of interdependence between projects are presented in subsection 4.2.

The existence of such interrelationships connecting different projects is usually associated with a shared portfolio goal or benefits that can be reached through the interactions between these projects [33], [34]. For example, sharing scarce resources among multiple projects will probably result in an overall cost saving meantime the opportunities of new knowledge being generated would be increased. Such economic and strategic benefits tend to be on top of many discussions that both researchers and practitioners would acknowledge as essential for any project portfolio to succeed. However, increasing the connectivity between projects (where each project has its unique number of constraints and risks), can be a source of further benefits but in the meantime could be a source of management difficulty.

Project portfolios are not only influenced by their immediate environment; instead, they are likely to interact with the external environment as well. According to this view, Gear et al. [34] emphasized that interdependencies between projects can either be influenced by factors external to the organization or by factors internal to the organization. External interdependencies can “arise over time from overall social and economic changes which have effects that cut across many, if not all, subsets of the project set” while internal interdependencies can “arise if the resource requirements and/or the benefits of one project are thought to be significantly affected in magnitude and/or timing by the selection or rejection decisions relating to one or more of other projects in the set” [34, p. 739]. As an example for external interdependencies, a sudden change in market conditions could lead to priority variations in the projects comprising a portfolio. Consequently, some project interdependencies, if not all, will be forced to adapt to these changes. As an example of internal interdependencies, an unexpected delay in one project could affect other dependent projects (in the portfolio) leading to an overall delay in the completion time of a new product or service.

Interdependencies between projects are likely to vary in their types, patterns of interaction, and the cost/benefit returns that they might produce. In the following subsections, a thematic analysis based on close study of the corresponding literature are presented and discussed. First, a brief description of different types of project interdependencies are presented to understand the importance and applications of each type. Different interaction patterns can take place as a result of projects being interdependent; this is another important issue to be highlighted in the second subsection. Cost/Benefit effects (as outcomes of the interaction process) constitute a crucial aspect to consider; this matter is presented in the third subsection.

4.1 Types of interdependencies

This section provides a description of various types of interdependencies that may exist between different kinds of projects across a portfolio of IT/IS projects. Among the interdependency types frequently discussed in the literature are: resource interdependencies; technology interdependencies; technical interdependencies; market interdependencies; and learning-based interdependencies.

Resource Interdependencies: result from sharing common resources across multiple projects or “wait for scarce resources until they are released by another project” [2, p. 556]. It is common that such interdependencies arise in an effort to cut the total portfolio cost [35]. *Example*: an expert who is taking part in different projects can simultaneously work on more than one project. Otherwise, each project is required to wait until that expert is released. *Interaction effects*: sharing the expert cost among the projects would lead to an overall cost reduction while the portfolio is in progress. *Authors*: [2], [19], [22], [28]–[30], [34], [36]–[41].

Technology Interdependencies: this type of interdependencies helps to leverage technical knowledge across multiple projects [22], [30]. Technology interdependencies are more frequent in technology provider companies due to their important role of enhancing technical collaboration and knowledge diffusion across projects. *Example*: a project of developing a new-generation of CPUs is likely to be dependent on another project developing a new operating system release. Both projects should complement one another by sharing the design knowledge of their components to produce a reliable computer. *Interaction effects*: the knowledge diffusion represented by knowledge sharing between the two projects would result in building a reliable computer. *Authors*: [22], [30].

Technical Interdependencies: occurs when the technical success/failure in one project affects the probability of success/failure in another project [28]. In another word, the output generated by one project is a determinant of the success of another project. *Example*: the implementation of a Data Warehouse (DW) system will probably require connecting to other enterprise-wide systems in an effort to capture and store different types of information for future use. Meantime, another project is to implement a Business Intelligence (BI) tool that relies on data being accurately captured and stored by the DW system. In this sense, the DW project is more significant since it can either limit or support the success of the BI project. *Interaction effects*: the interaction can either lead to positive or negative outcomes depending on the behavior of the leading project. *Authors*: [2], [13], [19], [28], [29], [35], [36], [38], [42]–[44].

Market Interdependencies: stem from market-related conditions that may impose additional challenges on project(s). Therefore, the affected project(s) might have to be reconfigured to address these conditions. Reconfiguration can take different forms including new product diffusion into an already existing products' market or a product utilizing a current product's market knowledge [22]. *Example*: the installation of a project capable of providing advanced digital communication solutions is inevitably going to break up a project capable of providing analog communication. *Interaction effects*: linked to this example, and as an effect, the organization will gain a competitive advantage by offering innovative services in the presence of their digital communication platform. *Authors*: [22], [25], [31].

Learning-based Interdependencies: stem from the need to incorporate the capabilities and knowledge gained from another project. *Example*: It can be more beneficial, for a service development team, to utilize the available knowledge (documentations and expertise) of a previous project in order to develop a new service with more attractive features. *Interaction effects*: learning through previously completed projects would lead to knowledge diffusion and innovation. Authors: [2], [13].

In Table 1, a summary of the different types of project interdependencies can be seen, together with the number of references per each.

Table 1. Summary of types of project interdependencies

Category	**Description**	**Number of References**
Resource interdependencies	This type of interdependency occurs when there is a need to share resources or wait for scarce resources until another project releases them	12
Technology interdependencies	The need to leverage common technology across multiple projects	7
Technical interdependencies	Occurs when the technical success in one activity affects the probability of success in another activity	11
Market interdependencies	Stems from a new product diffusion into an already existing product market or a product utilizing a current product's market knowledge	3
Learning-based interdependencies	The need to incorporate the capabilities and knowledge gained through another project	2

4.2 Patterns of interaction in interdependencies

After a brief description of five different types of project interdependencies and their applications, this subsection sheds light on different interaction patterns that can result from projects being interdependent. Although there yet have been no unified structure for project interdependencies, the classifications driven by Thompson (1967) [45] are often cited by most studies on project interdependencies. According to Thompson's view of interdependencies between organizational parts, interdependencies between projects can take three distinct forms including pooled, sequential and reciprocal (Fig. 1) [32], [45]. Pooled interdependence is a seamless association between projects comprising a portfolio, where one project outcome can indirectly impact the performance of the project portfolio as whole, and thus other contributing projects. In other words, a project can be independent of other projects. However, a failure in that project outcomes can threaten the entire project portfolio and hence other projects in the same portfolio as well. For instance, the implementation of a Data Warehouse (DW) system shall enhance the decision-making process in the organization. However, poor quality of data generated by the DW system can negatively impact the decision-making process and might end up in poor project portfolio performance. A sequential interdependence is a serial relationship between two or more projects where a project requires another project's output as input for its progress. For example, the implementation of a Billing System (BS) (for a telecom company) will probably include testing different call usage patterns generated by a Network Switch (NS). In this case, and in order for the BS project to progress, the NS project has to provide the possible combinations of service usage as input to the BS project. From this follows that project portfolios with sequential relationships become more complicated and difficult to coordinate as the degree of contingency increases [32]. A reciprocal interdependence, on the other hand, is a mutual relationship between two or more projects. This means that the project portfolio becomes more complex due not only to an increased degree of contingency, but also to the more reliance on coordination by mutual adjustment [32]. In other words, Project A' output is required as input for another Project B and conversely, Project B's output is required as input for Project A. For instance, perhaps both BS & NS projects (from the previous example) have to go through mutual adjustments before both projects can be completed. Fig. 1 illustrates Thompson's three forms of interdependencies which are stemmed from organization studies [41]. However, they are cited by many studies on project interdependencies. Most of the previously stated interdependency forms, if not all, are likely to exist in all kinds of IT/IS project portfolio where a reciprocal interdependence is considered complex [32]. A general example, which can be tracked back to the former two examples, is a project portfolio in a telecommunication service provider company. In such project environment, many and different communication elements (i.e. multiple software and hardware components of various vendors) have to undergo a lengthy integration process. Consequently, the projects embracing these elements have to carry out part of their activities through collaboration and mutual adjustment as they come to be interdependent. From this example, it is possible to assume that the three forms of project interdependency have at least occurred once. In other words, any occurrence of reciprocal interdependence would also indicate that both sequential and pooled forms have taken place [32]. Probably, interdependencies between projects can have other forms than those specified by [32], [45].

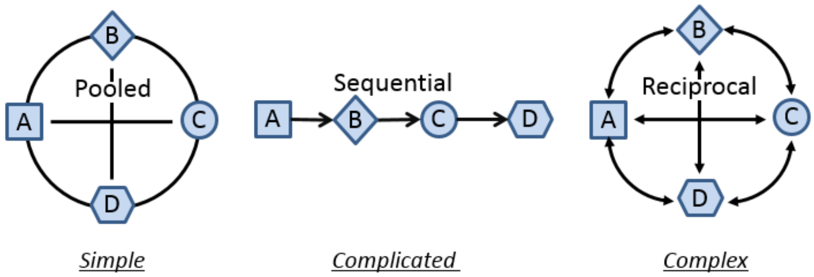

Fig. 1. Thompson's classification of interdependencies (adapted from [32], p. 54)

Although the three interdependency forms are good at depicting the connections between projects still, they remain at a high level of abstraction. A close-related aspect, at this point, is to recognize the interaction (i.e. as a transformation process) accompanying the project interdependency. Such transformational process would involve transforming certain inputs into desired outputs [39]. During that process, different interaction patterns can take place and different interaction effects can be generated (more about interaction effects is discussed in the next subsection).

Kundisch et al. [39] have synthesized a common semantic that could help in understanding different interaction patterns between projects and their effects in the domain of IT/IS project portfolio. They classified interactions between projects into three categories (Fig. 2): 1) Resource-Resource interaction; 2) Output-Output interaction; and 3) Output-Resource interaction.

Resource-Resource interaction: is about sharing resources among projects to optimize organizational performance and gain economic advantages. For instance, a technical expert can simultaneously participate in more than one project. This would result in cost decrease in each project, and thus the total development cost of the project portfolio is also decreased. This pattern of interaction can take place in all interdependency forms (i.e. pooled, sequential, reciprocal).

For instance, in a reciprocal interdependency between the BS and the NS projects (as described before) a typical Resource-Resource interaction would occur if one expert is participating in both projects.

Output-Output interaction: is an emergent relationship between two or more projects' outputs in which the sum of outputs produced by each project can result in different project portfolio performance. For instance, two distinct projects (in addition to their main purposes) are capable of providing a billing functionality. If both projects are requested to deploy this functionality then, the organization can benefit from having a redundancy. This pattern of interaction is likely to be associated with a pooled form of interdependence.

Output-Resource interaction: is a contingent relationship between the outcomes of one or more projects and a resource availability for another project(s). For instance, the installation of a billing system would necessary require a hardware equipment to be available. However the hardware equipment can be a stand-alone project, but it has to be completed before the billing system can be installed (i.e. the hardware equipment needs to be ready by the time the installation of the billing system is started). This pattern of interaction between projects is likely to occur among sequential and reciprocal interdependencies.

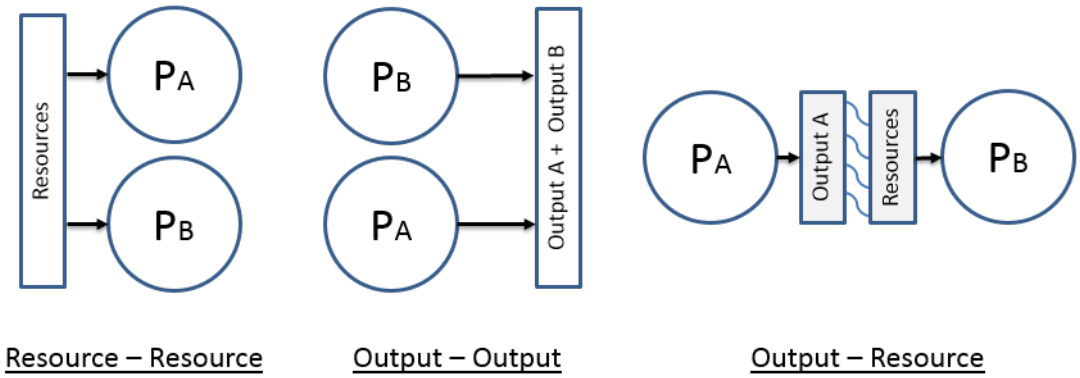

Fig. 2. Patterns of interaction in interdependencies (adapted from [39], p. 483)

Probably there are other patterns of interaction which can be a subject for investigation in future research.

4.3 Cost/Benefit effects of project interdependencies

In the previous subsections, we have overviewed the literature on project interdependencies' types, forms and patterns of interaction. In this part, we bring the attention towards the effects that project interdependencies can bring to project portfolios.

The importance and criticality of project interdependencies have gained much attention in project portfolio management studies due to their contribution to value creation and cost saving. Such wide-ranging benefits can be attributed to the synergistic interactions of particular projects [38], [46]. Several methods and techniques were established to support exploiting such benefits and, therefore, supporting the decision-making for project selection (e.g. multi-objective evolutionary algorithm [29]). A common tradition between these approaches is their advocating of optimal resource utilization and overall cost reduction. For example, developing a portfolio consisting of both IT and IS projects can benefit from sharing hardware and software capabilities among its projects. Hence, the development cost of sharing project resources is lower than the total cost of carrying out the projects individually. On the contrary, a stream of studies has addressed some adverse effects on the project portfolio as a result from improper resource utilization [19], [39]. For instance, the cost of assigning one project team to handle simultaneous projects at a time can be foreseen as more cost effective than assigning a separate team for each project. However, further expenses might be involved to offset the set-up costs from extra management efforts and extra working hours.

Table 2. Cost/benefit effects of project interdependencies (adapted from [39], p. 483)

Interaction pattern	Competitive	Complementary
Resource – Resource	Cost ↑	Cost ↓
Output – Output	Benefit ↓	Benefit ↑
Output – Resource	Cost ↑	Cost ↓

In a recent study, Kundisch et al. [39] have identified six positions where negative and positive outcomes from project interactions can be anticipated (Table 2). Negative outcomes would result from projects being entangled with competing setup (i.e. the received benefits from projects being interdependently arranged is lower than projects being independent). Along the same line, positive outcomes would result from projects being engaged in a complementing setup (i.e. the received benefits from projects being interdependently arranged is higher than projects being independent). Both competing and complementing outcomes can take place in three different patterns of interaction including Resource-Resource, Output-Output, and Output-Resource.

Resource-Resource interaction:

1) Competitive resource utilization interaction**:** occurs when a joint use of resources among projects results in overall cost increase. Example: in order to reduce the project cost, a technical expert has to participate in different projects. However, this might result in an overall cost increase due to increased working hours. Conversely,

2) Complementary resource utilization interaction**:** occurs when a joint use of resources among projects results in an overall cost decrease. Example: the same expert can work for different projects without additional cost if proper task scheduling arrangement is considered.

Output-Output interaction:

3) Competitive output interaction: the sum of two or more projects' outputs can deteriorate the expected benefits from implementing the projects due to overlap in the projects' outcomes. Example: two distinct projects are capable of providing billing functionality. If both projects have deployed the same billing functionality, then this could result in unnecessary maintenance cost. Conversely,

4) Complementary output interaction: the sum of two or more projects' outputs can enhance the expected benefits of implementing the projects due to appropriate overlap in the provided services. Example: If both projects have deployed the same billing functionality then the organization can benefit from having a backup system in case of an emergency.

Output-Resource interaction:

5) Continuous competitive contingency interaction: the output of one or more projects can deteriorate resources availability for another project(s). Example: the implementation of a standardization project (to improve customers' experience) will probably impose new requirements on other related projects in the portfolio. In response, the influenced projects might need to consume more resources to comply with that demand. Within such a scenario, the adjacent project(s) might suffer from resource shortages. Conversely,

6) Continuous complimentary contingency interactions: the output of one or more projects can enhance resources availability for another project(s). Example: the implementation of a resource management functionality (to

improve resource utilization) might result in increasing the availability of resources. Within such a scenario, the adjacent project(s) will benefit from procuring extra resources.

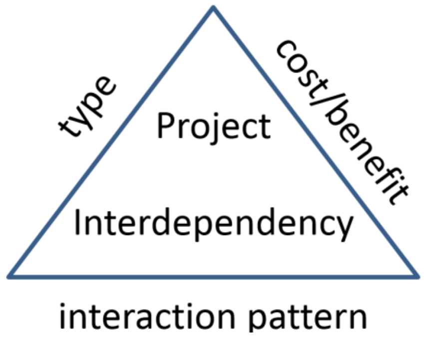

Fig. 3. Constructing perspectives of project interdependencies

In summary, IT/IS project portfolios (e.g. new product/service development portfolios) tends to embrace a hybrid set of fragmented projects that would very much result in raising a substantial number of project interdependencies. In such project environment, managers would have to deal with different project elements and oversee the operations of the interdependent ones. Every single activity between projects has to be well thought for and well coupled with the portfolio's overall goal. Overall, managers have to realize that the challenge of managing project interdependencies resides in the variety of interdependencies a project portfolio might possess. Variety in this sense, and in connection with Ashby (1964) [47] view, is the number of possible states a project interdependency can have. In this respect, we share Teller et al.'s (2012) [48] systematic perspective on project portfolios. The authors have emphasized on three main complexity determinants of a project portfolio. These would include [48]: (1) the number of elements (i.e. the projects and their related parts); (2) the degree of interdependence between the elements; and (3) the magnitude and predictability of changes in the elements and interdependencies. According to this view, the complexity of managing project interdependencies can significantly increase with an increasing number of projects/sub-projects. Similarly, the higher the degree of interdependencies between projects/sub-projects and the rate of change in the business conditions are another source for increasing management complexity. For example, managing a project portfolio of a multinational ICT service provider is more complicated when compared to a project portfolio of a medium-size IT service provider. From this example, the number of projects (elements) would pose a particular challenge in the management of the ICT project portfolio due to the substantial number of projects and relatively large number of interproject activates (interdependencies). Another source of complexity can be attributed to three interlocking perspectives preserved by every project interdependency, namely project interdependency type, the pattern of interaction, and cost/benefit impact (Fig. 3). We regard these perspectives as relevant for all project interdependencies.

5. Effects of poor project interdependencies management

Placing adequate considerations to project interdependencies along the project portfolio development cycle is of particular importance in the project portfolio success. One motivating factor behind the need for these considerations is to avert wrong selection of the portfolio projects [39] which might end in wrong portfolio spending. Also, less attention to project interdependencies may result in a skewed project portfolio direction with respect to the intended objectives of combing the projects [16]. Several studies have pointed out to different kind of problems that can result from ineffective management of project interdependencies. We conclude with four major problem areas as following: 1) resource waste; 2) schedule slippage; 3) budget waste; and 4) inter-project competition. A resource waste would arise from improper utilization and/ or sharing of scarce resources between interdependent projects [20], [25], [30], [49]–[51]. For instance, an expert has to play a role in several simultaneous projects. Although the expert can be synchronized between the projects, s/he is unable to participate in all projects as no task scheduling is considered. Another impact is the risk of having a schedule slippage where a delay caused by one project may propagate to another interconnected project(s) leading to overall delay in project portfolio completion [50], [52]. As an example, if two projects are technically interrelated then a delay in one project could cause a delay in other project(s). A budget waste will likely occur when interdependent factors among projects are not considered while projects are selected [28]. For example, instead of having two separate projects, both projects can be bundled into single project if the interdependencies between those projects are early considered in the planning phase. Therefore, there is a chance that the financial resources of the company are saved due to considering the interdependent factor between the projects. Inter-project competition is a state when projects start to compete against scare resources to gain more power over other projects and receive more support from top management [50], [53]. This kind of problems will likely to appear in certain organizational structures that do not support an appropriate project-oriented culture. Table 3 shows a summary of negative effects of ineffective management of project interdependencies found in the literature.

Table 3. Impacts from ineffective management of project interdependencies

Risk	Description	Authors
Resource waste	Improper allocation of resources among interdependent projects can lead to resources being misused or misplaced	[20], [25], [30], [49]–[51]
Schedule slippage	A delay caused by one project may propagate to another interconnected project(s) leading to an overall delay at the project portfolio level	[20], [25], [49], [50], [52], [54]
Budget waste	Less consideration of the interdependent factors among projects can lead to poor selection of projects and consequently wasting company's financial resources	[28]
Inter-project competition	Interdependent projects may start a power game to gain more control over company resources	[50], [53]

6. Barriers to effective management of project interdependencies

In connection with what have been raised so far, this part brings into light part of the managerial challenges that may arise when handling a large network of project interdependencies. Several studies have reported evidence of problems affecting overall project portfolio performance. For example, one empirical study has highlighted six problem areas that pose challenges for managing project portfolios. These areas include [55]: (1) inadequate portfolio level activities; (2) inadequate information management; (3) inadequate project level activities; (4) lacking resources, competencies and methods; (5) inadequate management of project-oriented business; and (6) lacking commitment. Only some of the retrieved articles on project portfolio management have paid attention to barriers that may hinder effective management of project interdependencies (e.g. [2], [16], [30]). Among these studies, one empirical study has found that insufficient inter-project learning and absence of specialized methods may create difficulties in managing project interdependencies [2]. The authors have related the problem of insufficient inter-project learning to an inappropriate flow of knowledge between projects. As a result, less chance for lessons learned to be captured and transferred to other projects. This could impact learning from projects' mistakes and would negatively impact dealing with project interdependencies. The absence of a specialized method that deals with multi-level interdependencies is another confirmed problem by the same authors. The challenge is presented as a matter of managing a high accumulation level of project interdependencies (i.e. a state of a project being interdependent with many projects). To deal with this issue, the authors have suggested a network mapping approach that uses visual representation to help in understanding and dealing with such accumulations of project interdependencies. The same approach can be used, as well, as a tool to enhance project communication and decision-making.

Another empirical study has investigated issues (from six leading high-tech organizations) of importance for effectiveness in managing a group of multiple projects. Overall, the study has indicated that ineffective inter-project processes and incompetent multi-project management pose a challenging aspect of managing project interdependencies [16]. Inter-project process, in this sense, is referred to the necessary steps for carrying out concurrent projects to achieve a certain objective. Such process is important for managers with multiple project management responsibilities to optimize their resource utilization and facilitate multitasking activities. On that account, this would enhance managing project interdependencies. The other raised problem (by the same study) is related to managers' competencies in managing multiple interrelated projects. Managers with multiple-project management task should possess the skills of managing individual projects as well as the ability of managing the interdependencies that emerge between these projects. In this respect, project managers lacking appropriate management skills is highlighted as negatively impacting project interdependencies.

7. Conclusion

In this review study, we have highlighted the potential role and contribution of project interdependencies in the success of project portfolios. We have shown that managing project interdependencies within IT/IS project portfolio environments tend to be a complicated, rather a complex task. Much of this management complexity is due to the total number of projects and their related parts alongside the degree of interdependence between these parts [48]. Another source of complexity can be attributed to the possible number of states (variety) a project interdependency can have. Bearing this in mind, managers would have to consider dealing with various project interdependency types including resource, technology, technical, learning-based, and market interdependencies. Each of these types would have to serve a distinctive purpose with regard to its role in fulfilling the overall portfolio goals. Another issue for consideration is the interdependence form that two or more projects should have and the patterns of interaction accompanying each. Thompson (1967) [45] has distinguished between three forms of interdependence including reciprocal, sequential and pooled. A reciprocal form tends to be complex while the other forms tend to be complicated and simple, respectively. In company with these interdependency forms and in order to produce the intended outcomes from each, different patterns of interaction would take place including Resource-Resource, Output-Output, and Output-Resource interactions [39]. As results of these interactions, managers should realize that different cost/ benefit outcomes can be produced according to their respective targets.

In view of many articles written on the management aspects of project interdependencies, only a few researchers have pointed out the reasons that might negatively impact the management of project interdependencies. Among those reasons is insufficient inter-project learning, the absence of specialized methods, and ineffective inter-project processes. On the other hand, it is crucial to consider the consequences of ill-managed project interdependencies. In this regard, several undesirable effects can occur including the problem of resource waste, schedule slippage, budget waste and inter-project competition. Both areas can be subject to further research.

In conclusion, although much research has paid attention to project selection methods and project interdependency management, there are still many questions to be solved concerning how to handle these interdependencies. In review of the literature, a number of themes stood out which have drawn our attention to three perspectives on the management of project interdependencies. These perspectives are, namely: 1) project interdependency type; 2) the patterns of interaction; and 3) cost/benefit effects. We consider these perspectives as relevant for all project interdependencies. To arrange for a desired project portfolio outcomes, managers should know how to deal with all aspects and measures that relate to these three perspectives which would also help to understand the project portfolio as a whole. Meantime, managers need to realize the complexity aspects of managing project interdependencies particularly in the presence of unexpected events. More research efforts are required to address the managerial issues concerning large project portfolios with many project interdependencies. This article contributes to the understanding of project interdependencies and their management related challenges. In extension to the issues addressed in this article, we are engaged in an ongoing research addressing how to handle project interdependencies.

Future research in this area should further investigate the complexity of managing project interdependencies when the environmental context of the interdependencies is changing.

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