Governing Technology Debt: Beyond Technical Debt

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ABSTRACT

Technical debt has successfully captured the interest of practitioners and researchers alike. We argue that the concept of technical debt holds much more currency within the strategic Information Systems literature. Hence, we have developed a research framework for expanding the concept of technical debt into a new concept we dub "technology debt". This expanded concept aims at capturing the path-dependencies reported in literature in regard to digital investments, and to make these both researchable and manageable. Technology debt is defined as the constraining effects of previous governance decisions on future decisions, including technical debt as important factor, but not unique. According to the findings, technology debt is a feasible method for highlighting the constraining aspects of IT investments and including these in the investment evaluation by governing body. This offers support for corporate stakeholders involved in the decision-making surrounding IT related investments, particularly in IT governance and management processes.

KEYWORDS

IT investments, Technical debt, Technology debt, IT governance

TechDebt '18, May 27–28, 2018, Gothenburg, Sweden
© 2018 Association for Computing Machinery.
ACM ISBN 978-1-4503-5713-5/18/05…$15.00
https://doi.org/10.1145/3194164.3194169

1 INTRODUCTION

Information Technology (IT) seems to suffer bias towards positive perceptions and assumptions in regard to the technology itself. The perception that IT acts as a benevolent force in the quest for competitive advantage [9, 12, 32, 54, 56, 58]. The organization invests in IT and the investments accrue benefits over time, despite the inherent lack of empirical evidence of a positive Return on Investment (ROI). The necessity for a more thorough understanding of the IT investments would be based on the assumption that IT not solely enables but also (simultaneously) constrains businesses. For Leonardi [35], IT artefacts are seen as both affording functionality as well as constraining corporate repertoires.

The term technical debt refers to delayed tasks and immature artifacts that constitute a "debt" because they incur extra costs in the future in the form of increased cost of change during evolution and maintenance [34, 46]. The software engineering community is converging on defining technical debt as making technical compromises that are expedient in the short term, but that create a technical context that increases complexity and cost in the long term. The technical debt metaphor provides an effective mechanism for communicating design trade-offs between developers and other decision makers [5]. The cause of technical debt can be a business process, a top management decision, an action (or lack thereof), or an event, such as schedule project pressure, unavailability of a key project person, or lack of information about a technical feature. But, the consequences of technical debt can affect the whole value of the system, the costs of future changes, the project schedule, and the system quality [5]. The business objectives of the sponsoring organization developing or maintaining the software system are affected in several ways: through delays, loss of quality for some features of the system, and difficulties in maintaining the system operations [5].

Therefore, technical debt has successfully captured the interest of practitioners and researchers alike [30, 33, 36, 38, 45]. At the same time, it suffers from some provinciality, i.e. it is seldom used outside of the software engineering literature and context. Previous attempts at transgressing the realm of software engineering mainly have focused on operationalization, yet we argue that the concept of technical debt holds much more currency within the strategic Information Systems literature.

Hence, we have developed a research framework for expanding the concept of technical debt into a new concept we name "technology debt". This expanded concept aims at capturing the path-dependencies reported in literature in regard to digital investments, and to make these both researchable and manageable.

Thus, technical debt deeply influences maneuverability of the organization, reducing partially the value of future IT investments as important factor of the technology debt. As Baker, Song and Jones show in [6], other aspects about the benefit of investment in IT should be considered at the corporate level, such as the improvement of the organization's performance, reinvestment gains and the resurgence of new opportunities for future investment, among others, instead of merely checking the cash flow decrease to justify the investment in IT.

Provided the rationale that IT investments are changing in nature; that there is a bias towards seeing said investments as solely enabling, and, to focus on short-term, immediate investment evaluation building on capital appraisal techniques, this study also aims to contribute to the literature surrounding the governance of digital investments and debt, including technical debt. This is achieved through developing and presenting a method for investment evaluation and illustrating said method through a case study.

The method applied in this study consists of two main parts. First, we worked with conceptual modeling based on a literature review in order to derive the definition, process and typology of technology debt. This work involved utilizing the precursory findings presented in more detail by Magnusson and Bygstad [37]. Second, we conducted a number of case studies intended to illustrate the proposed method of technology debt, whereof we include on in this paper. Third, we show the compatibility of the process of technology debt within the IT investments governance decision-making in ISO/IEC 38500 standard.

2 RELATED WORK

Various studies show that IT does contribute to improved productivity, higher profitability, and enhanced customer satisfaction [16, 41, 48, 49]. These contributions are aligned with governance body's ability to steer the investments in a desired direction, thus creating/adding business value. Subsequent increases in business value are vital to the future of the corporation [31, 50, 59]. Previous studies have acknowledged negative impact of IT issues such as the regulative regime of technology [28], material precedence [35], path dependencies [60], resource dependencies [58] and risks [8] to name but a few.

The use of IT and IT-related investments accounts for a major and growing proportion of an organization's costs [56]. Most practitioners and researchers agree with the statement that, on average, IT deployment improves performance and increases the value of an organization [11, 13]. The impacts of multiple factors have been investigated within the IT value include IT capabilities [4, 21, 40, 52], IT alignment [10, 29, 53], IT governance [18, 27, 55, 57], IT strategy [14, 15, 20], IT investments and project portfolio [25, 42] and IT performance and business value [1, 2, 39], to name a few.

In any case, there is a strong focus on retrospective, financial assessments on whether or not the IT investments have achieved profitability [19]. More forward-looking assessments, utilizing not only financial but also non-financial measures are scarce in theory as well as in practice [51]. Moreover, strategic agility has been proposed as a novel way in approaching the previously predominating view of sustainable strategic advantage [17, 22]. There are also several works about the missing value of IT by itself [23] and then, the appearance of IT governance issues for intending to guarantee the IT investments valorization.

There are also findings suggest that not all IT expenditures are successful or add value to the business [47].

Governance bodies are making decisions about different options but does not take into account how the meaning of options change as an investment process progresses. As a result, it is difficult to apply current theorizing to rigorously examine digital options [46]. One aspect of IT governance is to work on striking a balance between debt and options. In this regard, [52] captures the interplay between debt and options in the evolution of technological products. There are "design moves" that affect the balance between debt and options.

Against these related work, we adopted a different approach, and propose the concept of technology debt in previous work [37], where one of the main factors is technical debt. The aim of this study is to present and illustrate said concept through a method. We also propose how to include the process of technology debt into the IT investments decision-making in IT governance standardization.

Thus, in section 3 we show our initial findings regarding IT investments, technology debt and IT governance framework. In section 4, we propose our method and a real case as example of implementation. Section 5 is devoted to discussion followed by conclusions and research open problems.

3 PRECURSORY FINDINGS AND FRAMING

IT investments account for a large part of the organization's budget [24], and in those companies that are technologically more intensive, IT investments can exceed capital expenditures [56]. Consequently, organizations must not only manage these investments properly but also govern how they are carried out. For this reason, de facto and de jure standards on IT governance include activities and principles to align IT strategies with the business objectives of the enterprise, trying to assure the value derived from use of IT. Investments on IT are one of the most

important decisions for governing bodies that affect not only the alignment itself, but also the business outcomes.

On one hand, not governing IT is no longer a plausible option for any organization. Without IT governance, organizations and companies either face loss of competitive advantage opportunities, or they must prepare for limiting the business's operational achievements and even failures due to IT [27].

On the other hand, IT investment decisions, past and present, either facilitate or restrict the options of future IT investments. That is, past and current IT investment decisions within the same organization impact on the previous factors of value-seeking and organizational flexibility [37]. This technological heritage, paradoxically, can limit actions and decisions, while business, market, regulatory and stakeholder expectations (public or private) push to improve IT efficiency and productivity.

IT capabilities are a key factor in the development and competitiveness of an organization. However, it is not clear how to quantify the positive (or negative) impact of IT use. It is clear that if there is a positive impact of IT on business and it has been measured as the value of IT in the organization, mainly in terms of cost reduction or productivity increase, IT already seems to be profitable. Although, at present, other sources of IT value are considered, in addition to previous evidence [23]. It can also ROI in IT, alignment with business initiatives, value gained in project execution, improvement of products / services delivered on time (time to market), etc. No less important is the adequacy of IT investments, so there is a constant need to achieve better IT governance. This statement about the adequacy of the level of IT investments is also shared by other authors such as Nolan and McFarlan [44] and Van Grembergen and De Haes [21]. Thus, IT governance, encompassed within the organization's corporate Governance, must assume the responsibilities of IT investments as sources of IT value in the organization.

Therefore, the role of IT investments is of strategic importance and should be viewed as a tool for gaining competitive advantage and not just as acquiring IT assets. However, they may have also a negative impact in the form of cumulating more technology debt [26].

3.1 Technology Debt

We introduce the concept of technology debt together with the underlying assumptions. In addition to this, we present a process model and typology for the concept in order to operationalize the method.

3.1.1 Assumptions and Definition

There are four assumptions underlying the proposed concept:

1. Debt is accumulated over time as a consequence of decisions.
2. Debt is associated with a cost of interest.
3. The cost of interest and the total amount of debt influences prospective decisions, through limiting the amount of funds available.
4. Debt is a necessary element of the capital structure of the firm.

Following these four assumptions, we argue that the IT function of a firm has its own particular form of debt, i.e. a technology debt. This debt is in the same manner as assumption #4 a necessary element of the IT function's capital structure, yet in line with assumption #2 it is associated with a cost of interest. This interest is manifested in the decrease in potential prospective decisions, through delimiting the amount of available funds (assumption #3) in the wider notion of the term. Each decision made by the IT function will lead to an increase or a decrease in the debt and consequent change in the cost of interest.

Technology debt is defined similarly as:

- Accumulated obligation owned by current CIO (debtor) to future CIO (creditor), where previous decisions limit prospective decisions.

We define the (interest) cost of technology debt as:

- Cost consisting of a decrease in maneuverability in future options.

These definitions are partially used in technical debt literature, but technology debt concept goes beyond the technical debt scenarios, including also other types of debt. Based on these definitions, we regard the acquiring of debt by the current CIO as a means for aspiring opportunities necessary at the time, at the cost of future decreases in maneuverability.

3.1.2 The process of Technology Debt

The process model that we propose as a means for studying technology debt focuses on the ex-ante and ex-post of the investment decision.

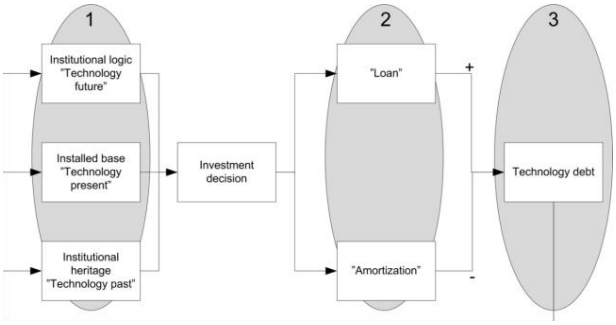

Figure 1: The process of Technology Debt in Magnusson and Bygstad [34]

In line with our institutional perspective, there are three main factors impacting the investment decision. First the institutional heritage ('Technology past'), constituted by the history of the organization and the fads and fashions in the surrounding environment. Second, the presently dominating institutional logic ('Technology future') of the organization and third, the installed base ('Technology present') comprised on the existing infrastructure and all its necessary supporting resources and processes.

The investment decision impacts technology debt through an increase and/or decrease of the debt. The increase is in the form of 'loans' where the investment leads to decreased maneuverability.

The decrease is in the form of 'amortizations', where the investment leads to increased maneuverability. Loan and Amortization is treated as metaphorical.

Technology debt is manifested in both a direct cost associated to constrained maneuverability ('cost of interest'), and, a recursive impact on the three main factors preceding the investment decision (1). The impact on institutional heritage is in forms such as a negative perception of the IT organizations ability to deliver. The impact on institutional logic is in forms such as necessary strategic changes pertaining to previous failures, and the impact on technology heritage is in forms such as increases in complexity of the installed base.

3.1.3 Typology

We will now devote attention to addressing the different types of technology debt found in literature in order to create a structure of different types. Given the abstract notions of the various forms of debt, we present a typology of the types of debt found in previous research in Table 1.

3.2 Technology Debt and Technical Debt

Companies sometimes take short-term decisions about processes, actions and events when developing new software artifacts. This will lead to the phenomenon called "technical debt" [7, 34]. The term technical debt refers to delayed tasks and immature artifacts that constitute a "debt" because they incur extra costs in the future in the form of increased cost of change during evolution and maintenance. The cause of technical debt could be originated from business units, business processes, govern body and top management decisions, project stakeholders actions, events, etc. but, the consequences of technical debt affect the value of the system, the costs of future changes, the schedule, and the system quality [5]. Additionally, the business units' objectives of the organization are affected in several ways: through delays, loss of quality for some features of the system, and difficulties in maintaining the system operations [5].

Table 1: Types of Technology Debt by Magnusson and Bygstad [37]

Organization	Mix of competence	The competence base for the IT department needs to match both the current and prospective needs. As the installed based often is built on elements of antiquated technology, this created a lag in terms of the competence base where this is optimized for maintenance and operations rather than modernization and development of new technology	Mayer & Nickerson, 2005; McMurtey et al, 2002; Paré & Tremblay, 2007; Hawk et al, 2012; Pérez-López & Alegre, 2012; Kowal & Roztocki, 2015
	Working environtment	Deficiencies in the working environment for IT co-workers create a difficulty in attracting and retaining relevant competences for future needs. The result is an amplification of lack in competence and growing problems associated with staff turnover and sick leave which hinders the ability to delive	Tong, Talk & Wong, 2013; Chang et al, 2012; Venkatesh et al, 2017; Ertük & Vurgun, 2015; Anthony-MacMann et al, 2017
Users	User satisfaction	Deficiencies in user satisfaction impact the user's willingness to actively work with the IT department to create improvements. This creates a seedbed of showdown IT and negatively impacts the level of internal IT utilization	Sun et al, 2012; Woxom & Todd, 2005; Legris, Ingham & Collerette, 2003; Kettinger & Lee, 1994; Leonard-Barton & Sinha; Hu, Hu & Fang, 2017
	Reputation	Deficiencies in delivery capability over long periods of time create a reputation where the users have a low level of trust for the IT department. This leads to a passive user culture an hinders future development	Hirscheim & Lacity, 2000; Reich & Benbasat, 2000; Sweetser, 2014; Purvis, Zagencyk & McCray, 2015
Technology	Infrastructure	Deficiencies in infrastructure lead to potentially long lead times for future changes and staffed demand for necessary modernizations / re-investments before new innovation with concrete benefits can be delivered. This leads to a marginalization of innovation, lock-in effects and redundant costs	Duncan, 1995; Henderson & Venkatraman, 1993; Bharadwaj, 2000; Bhatt & Grover, 2005; Khlan, Khouja & Kumar, 2012; Kumar & Stylianou, 2014; Hanseth, Monteiro & Hatting, 1997
	Shadow IT	Decentralized investment and non-sanctioned user-driven innovation creates a lack of synergies, efficiency and security	György et al, 2012; West & Gallagher, 2016; Shumarova & Swatman, 2008; Raden, 2005; Silic & Back, 2014; McDonald, 2014; Silic, Barlow & Back, 2017; Myers et al, 2017
	Technical debt	Lacks in previously conducted development in the form of missing documentation and high degree of shortcomings lead to increasing maintenance costs and difficulties for future development. Following an increased focus on agile development, this phenomenon is expected to increase over time	Kruchten, Nord & Ozkaya, 2012; Marinescu, 2012; Klinger et al, 2011; Conroy, 2012; Li, Avgeriou & Liang, 2015; Alves et al, 2016
	Governance	Biases in the configuration of governance creates a governance optimized for stability that does not cater to the needs for innovation	Magnusson, 2010; Banker et al, 2012; Guillimette & Paré, 2012; Presad et al, 2012; Van Grembergen & De Haes, 2044; Joshi et al, 2017; Dawson et al, 2016; Pang, 2014; Wu et al, 2015

Combining technical debt with finance theory infers certain implications on consequences of technical debt [3]. The three properties of going into financial debt are the following; first, it is supposed to be repaid eventually; second, it is supposed to be repaid with some kind of interest, meaning more than the original loan; third, if you cannot pay back for some reason, there will be a very high cost. However, unlike financial debt, technical debt almost never has to be repaid completely as it remains in the organization as its technological heritage [34, 36].

Based on technical debt and technological heritage a newly proposed theory named technology debt has been developed by Magnusson and Bygstad [37], including technical debt as this heritage particularly includes technical debt, due to delayed tasks and immature artifacts incurring in extra costs in the future in the form of increased cost of change during evolution and maintenance.

This technological heritage also includes IT governance debt due to sub-optimal IT governance framework implementation that will have a cost effect on the organization and its management. Therefore, the IT governance framework implementation should

consider not only IT investments governance but also IT debt, including its own debt.

Thus, governing bodies should know how to integrate these technology debt types under the governance model standardization. In fact, developing a normative framework with such dimensions for application of standards would be helpful for governance structures who are devoted to measurement, assessment, and reporting about technology debt. For example, [45] attempts to map the needs of technical debt management with known quality management frameworks. We use the ISO/IEC 38500 standard model to include not only tech debt but also the rest of types reported in table 1.

3.3 IT Governance, Technology Debt and Technical Debt

The ISO/IEC 38500 standard will provide guidance to assist governance body in the effective governance of IT enabled investments. The guidance provided in this standard comprises principles and a model, based upon ISO/IEC 38500. An unformal interpretation of the model in Fig. 2 is like following:

- Governance body supports the pressures of regulation, obligations, business and stakeholder expectations for any asset, including IT assets.
- Particularly, governing IT consist of monitoring, evaluating and directing these IT assets.
- In the case of IT investments decision-making, governance body should monitor issues and facts about the past and present IT investments performance and conformance, coming from IT management and operation; it should evaluate the strategic alignment of this management together with business value and risks; and finally, it should direct and decide about IT investments and should inform their success criteria to IT management.
- IT management should realize the benefits expected from governance body and should deliver new capabilities from IT assets.

Therefore, there are two IT investment governance-management cycles in the standard: one for direction and evaluation of current and future investments and another for monitoring current and past investments, their evaluation and direction.

Thus, the standard provides some guidance on the way governing bodies can own and lead the governance of IT enabled investments while providing support to those with delegated authority to deliver. The governing body will try to determine the IT value for the organization, including:

- Competitive advantage through delivery of new IT-business services;
- Improvements in organizational IT-business efficiency;
- IT cost reduction;
- Effective IT-business risk management;
- Compliance with legislation and regulations.

However, we argue that the value expected from IT enabled investments should consider also the corresponding incurred debt as we mentioned in previous sections, particularly the process model in Fig. 1, resulting a new vision for the ISO/IEC 38500 standard for IT investments and technology debt:

- In the case of IT investments, governance body should not only monitor issues and facts about the past and present IT investments performance and conformance, but also the types of technology debt the organization incurs;
- Governance body should evaluate not only the strategic alignment together with business value and risks but also the "loan" or "amortization" of the debt from the current and technology heritage. This heritage particularly includes technical debt, due to delayed tasks and immature artifacts incurring in extra costs in the future in the form of increased cost of change during evolution and maintenance and also governance debt, due to sub-optimal IT governance framework implementation that will have a cost effect on the organization and its management (see typology in section 4.3).
- And finally, it should direct and decide about IT investments and should inform their success criteria to IT management taking into account the cumulated technology debt.

Therefore, there two IT investment governance-management cycles in the standard: one for direction and evaluation of current and future investments and another for monitoring current and past investments, their evaluation and direction, are now complemented with the process model of Fig. 3.

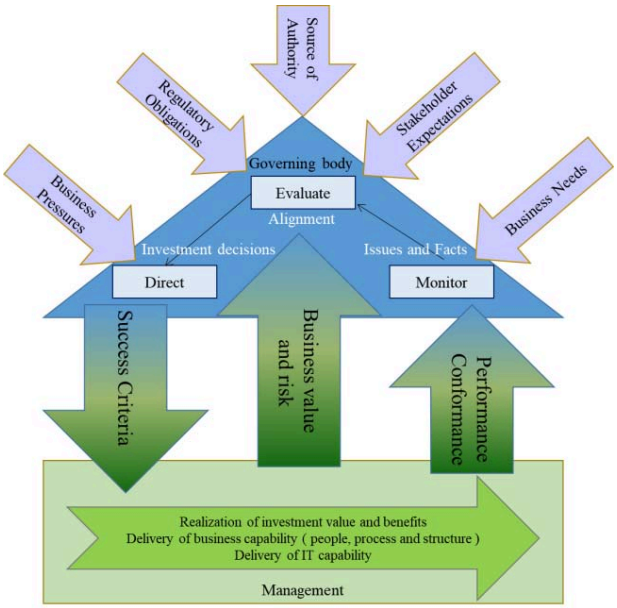

Figure 2: **IT investments in ISO/IEC 38500**

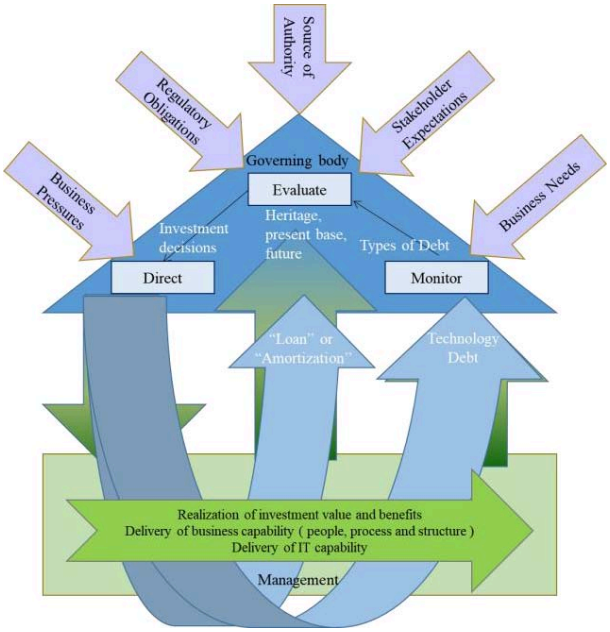

Figure 3: **The process of Technology Debt in ISO/IEC 38500**

4 METHOD

The method applied in this study consists of two main parts. First, we worked with conceptual modeling based on a literature review in order to derive the definition, process and typology of technology debt. This work involved utilizing the precursory findings presented above as a baseline and rationale for continued work, and a combination of literature from information infrastructure, network economy, corporate finance and accounting to chisel out a working definition and proposed theory of technology debt. A nucleus version of this has previously been presented in more detail by Magnusson and Bygstad [37].

Second, we conducted a series of case studies intended to illustrate the proposed concept of technology debt, whereof we include one in this paper. The rationale for only using one of the cases was due to the focus on theory illustration rather than theory testing.

4.1 Case selection

The case was selected on the premise of fitting the criteria for a situation where real-options were currently being considered for a major digital investment. The investment was an Enterprise Resource Planning (ERP) roll out to all subsidiaries, something that was not seen positive by the CIO and CFO of one of its subsidiaries. Through discussions, we saw a potential use of the Technology debt approach to create a more nuanced picture of how the decision to roll out a global template into the subsidiary would impact future maneuverability.

The subsidiary (Southie Ltd) is a wood supply firm with an annual turnover of €250M and approximately 150 employees. They are part of a larger conglomerate (Fortune 500) that during the past 15 years have been involved in the rolling out of a large-scale ERP solution. Southie Ltd is highly it-dependent and have created an information systems environment from primarily customized development since start. They have since the early noughties been adamantly opposed towards accepting the global ERP template, pushing for their uniqueness as an attempt to avoid corporate standardization.

The case is focused on a situation where two investment options are relevant by the subsidiary: either a continuation of the existing strategy of customized development or the roll-out of a global ERP template.

4.2 Data collection

Data was collected in the form of ten, semi-structured interviews with the IT staff (7) and users (3) directed towards collecting data in terms of how the two options (global template and customization) would impact technology debt. The informants were asked to assess each type of technology debt in relation to how the option in question would either increase or decrease it. This was done in a subjective manner using a Likert scale of 0-6 where 3 was deemed to be zero change in regards to existing technology debt (option 0). In addition to this, 50 documents related to the potential investment (either continued customized development or global template roll-out) were collected. The interviews were recorded and transcribed verbatim.

4.3 Method of analysis

On the basis of the interviews and the secondary data, the research team created an overview of the two different options and their resulting technology debt. This was then used as a means for both analyzing the differences in technology debt distribution and resulting impacts on future maneuverability of the two options, and, the potential value of the technology debt approach itself.

5 RESULTS

Through the data collection and analysis, we created a mapping of the two options on how these would change the current level of technology debt for Southie Ltd (see Fig. 4). Using seven-degree Likert scales and an assumed, idealized baseline of 4 as the current level of Technology debt, we then compared the two options in terms of if they would amortize or increase the loan (i.e. if the score was above (loan) or below (amortize) 3).

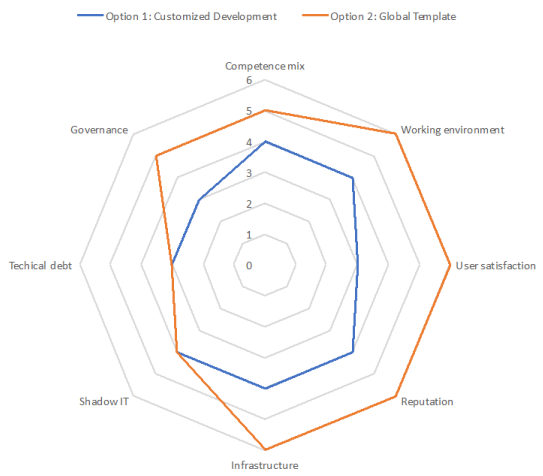

Figure 4: Results of Technology Debt assessment

As seen in Fig. 5, Option 1 is by far the best option in terms of future maneuverability. Option 1 amortizes 3 out of 32 points (baseline) and increases maneuverability for the subsidiary. Option 2 increases the loan by 9 out of 32 points (baseline) and hence decreases maneuverability. The difference between the two options is 12.

In terms of how said identified differences between the two options are distributed between the three types of Technology Debt, Organization constitutes 25%, User 42% and Technology 33%, i.e. the primary beneficiary of the future maneuverability would be the users. Both Shadow IT and Technical debt display a zero difference between the two options, i.e. there would be no consequence for these two regardless of which option is chosen.

The results of this analysis were communicated in a report to the CIO and CFO of the subsidiary, and in turn used as input for the investment evaluation process in terms of choosing between the two options. Following the decision to go with Option 1, the CIO expressed that the Technology debt analysis was instrumental in being able to justify not going with the global template and instead continuing along the same path as previously.

6 DISCUSSION

As illustrated in the case, technology debt holds apparent merits as a basis for assessing digital investment options for a firm. For the specific case firm, it allowed the managers to achieve an alternative perspective towards the two real options, and it allowed them to steer away from an investment that albeit apparently relevant for the firm, was proven to limit future maneuverability in a longer perspective. This ability of the concept of technology debt to identify and quantify aspects associated with lock-in effects and path dependencies is deemed a valuable contribution as a complement to more traditional investment capital appraisal methods such as ROI, EVA and TCO. Through this, we answer the call from Nielsen and Persson [43] about expanding the methodological plethora of digital investment evaluation.

In relation to technical debt, the findings that this particular type of technology debt was not affected by the choice in option are interesting. This warrants additional attention to the role of technical debt as a factor in digital investment evaluation. With previous research pointing to the detrimental effects of technical debt and the assumed variance of degrees of technical debt in digital investments, we can assume that this case presents an empirical outlier. The alternative interpretation of the findings, that we fail to assess technical debt due to shortcomings in the method applied is also possible and requires additional analysis of multiple cases in order to assess the reliability of the method of measurement. Both of these interpretations point to the necessity to expand technical debt as a factor for investment evaluation.

Concerning the links to governance frameworks such as ISO/IEC 38500, we see the concept of technology debt as an important contribution in regard to pushing for a less a-historic perspective towards governance. Through assessing technology debt and the impact of past and present decisions on the future maneuverability of the firm, we propose an expansion of the framework as seen in Fig. 5. In line with making the framework less a-historic in its approach, technology debt allows us to include past-related factors that research has highlighted as impacting firm maneuverability.

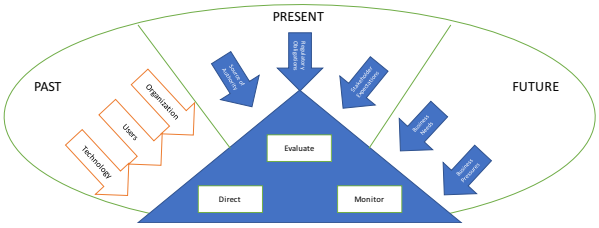

Figure 5: Proposed expansion of ISO/IEC 38500

There are three distinct implications for research. First, studies of technical debt need to inform the study of digital investment evaluation. Provided the growing interest in the measurement and assessment of technical debt, and the strong empirical evidence of the detrimental role of technical debt for firm success, we see new avenues for valuable research start to emerge.

Second, the proposed concept of technology debt, a conglomerate concept including technical debt may offer an interesting approach for supporting this need for future research. The anatomy of digital investments has a long history of inquiry, yet there is still an inherent perception that technology primarily acts as an enabler and not constrictor of future maneuverability. This is particularly relevant in times when the hype surrounding digital investments surges, and firms are keen on investing in digital technology and innovation.

Third, with investment evaluation being an integral part of the IT Governance of a firm, any change in evaluation method needs to be aligned with the underlying governance frameworks. Hence, changes in methodology cannot occur without changes in the frameworks per se. In this paper we propose an expansion of one of said frameworks, i.e. ISO/IEC 38500 to better cater to the function of time in governance. This should be seen as a first step

towards opening up research towards not merely accepting the frameworks out-of-the-box but also push for a research-infused re-design of the frameworks and their application.

In addition to these three implications for research, this paper offers two implications for practice. First, managers working with digital investment evaluation would be benefited by looking into current research within both technical and technology debt. Operationalization of the more negative aspects of digital technology for future success, or the dark side of digital investments if you so will, is still in its infancy but may offer food for thought for managers. Provided that the task of the top managers is to assure the sustainable, long-term success of their firms', digital investments need to be fully assessed before decided upon. The proposed concept of technology debt offers one such source of inspiration.

Second, with IT Governance being the setting within which the investment evaluation is conducted, the proposed expansion towards better taking into account path dependencies and lock-in effects is necessary. This requires instrumental changes in the IT Governance frameworks employed by the firm. To achieve this, we propose an audit of the existing governance with the perspective of seeing how the historic perspective is accounted for in the frameworks. Are we in an effective manner handling long-term aspects of our investments, and how do we assure that this is catered to in a continuous basis?

There are two main limitations of the research approach applied in this paper. The first is associated with the empirical aspects. With the illustration of the concept of technology debt being a single case study with limited data, this off course impacts the generalizability and perhaps representability of our findings. The validity of the findings is directly associated with what we measure through the proposed typology, and without the typological theory having gone through a rigorous theory testing, validity is questionable. We are currently working on a journal paper that will combine the different cases we have conducted as theory testing.

The second limitation is related with the links to the lack of enough experience of implementing ISO/IEC 38500 governance frameworks in real organizations and, particularly, its future development standard ISO/IEC 38506 of governance of IT enabled investments is not currently finished. The absence of a sufficient number of firms implementing ISO/IEC 38500 does not permit to evaluate our proposals for building particular frameworks of investments and debt together.

7 CONCLUSIONS

Technical debt is a very important type of debt, but not unique, due to the immature IT artifacts that constitute extra costs in their future evolution and maintenance. In this paper, we have pointed out other types of debt, including technical debt, under the umbrella of technology debt. We have illustrated with a case study, the use of technology debt to highlight that the governance bodies and senior executives must take debt into consideration in the same way as IT investments are considered. Fortunately, the ISO / IEC 38500 points out how to relate the management and control activities of IT investments made by IT managers. However, we have identified shortcomings with respect to technology debt, and particularly the technical debt, when it comes to direct, evaluate and monitor the construction and maintenance of IT artifacts. We have proposed a model for continuously directing and controlling technology debt within the standard.

We believe that this work should be expanded, studying other real cases and verifying which types of debt are more sensitive to the maneuverability of organizations. Technical debt because of its importance should appear as a determining factor in global debt, but also as an opportunity to govern IT management in a real way.

In future work we consider, deepen the types of debt, and see how they affect the digital transformation of companies.

Acknowledgements

This work was partially supported by the Marianne and Marcus Wallenberg Foundation. The authors would like to express their thanks to Anton Johansson and Christer Widell, two master-students at the School of Business, Economics and Law at Gothenburg University involved in collecting the data for the case. This work was also partially supported by the Erasmus+ KA2 projects ITG4TU and ITG4AU, coordinated by the ACSIC research group at University of the Balearic Islands.

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