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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 fourth number of the seventh volume of IJISPM, which is a special issue addressing the theme “Revisiting Information Systems Project Management Success in the Contemporary Era”. In this issue readers will find important contributions on the role of top managers in ERP business value creation, effects of investment assessment methods on IS/IT project success, design of citizen centric e-government projects, and megaproject complexity attributes and competences.

The first article, “An interpretive study on the role of top managers in Enterprise Resource Planning (ERP) business value creation”, is authored by José Fernando López-Muñoz and Alejandro Escribá-Esteve. This paper contributes to the body of literature on ERP business value by investigating organizational ERP development in view of the active involvement, vision, and direction of top management teams (TMTs). A top-down approach to ERP adoption and implementation was adopted with socio-material and social construction assumptions about the mechanisms that generate ERP business value. A single ERP case study was analyzed in an industrial setting by interpretive means, thus providing theoretically based, detailed and interesting insights. The research suggests that ERP benefits emerge during the TMT’s encounters with the ERP system through pragmatic action and situated improvisations. The findings suggest that ERP adoption is strongly influenced by TMT characteristics and social processes, while complementary process-change needs are perceived by the executive participation during implementation. The authors also suggest that when the ERP system goes live, a synergistic relationship termed TMT- information technology (IT) imbrication will create the technological infrastructure perceived as ERP value. At this post-implementation stage, various TMT characteristics and processes are proposed that greatly influence top managers’ patterns of imbrication behavior. Several propositions are developed and summarized in a framework to enhance the current understanding of managerial agency in achieving business benefits from ERP systems. The paper concludes with implications for top managers and future research directions.

The title of the second article is “An empirical analysis on the effects of investment assessment methods on IS/IT project success”, which is authored by Meltem Özturan, Furkan Gürsoy and Burç Çeken. As organizations’ investments on information systems (IS) increase, the assessment methods used during IS/IT investment decision-making process holds more and more importance. Since successful IS/IT projects are key to the sustainability of an organization, identifying the factors which have effects on project success carries useful insights. In this study, 18 assessment methods are identified based on the literature. A novel classification method is proposed and assessment methods are classified into financial, strategic, and organizational categories. A novel rule-based method for determining the size of IS/IT projects is also proposed. Detailed information on project characteristics, employed IS/IT assessment methods, and project success is collected for 110 real-world IS/IT projects. The collected data is utilized in ANOVA and Regression tests to examine the factors which affect project success. Use of organization-related assessment methods, which is proposed in this study, is found to increase the success rate of the projects. Obligation towards the project and use of multi-criteria methodology have significant relationships with project success whereas project size, use of gut feeling during evaluation, and employed system development methodology do not have statistically significant impacts on project success.



The third article, authored by Stephen Kyakulumbye, Shaun Pather and Mmaki Jantjies, is entitled “Towards design of citizen centric e-government projects in developing country context: the design-reality gap in Uganda”. E-government projects should be at the heart of service delivery in developing countries if the lives of citizens, especially the socially and economically marginalized, are to be improved. However, quite often in developing country contexts, citizens have been treated as recipients of technology projects through a top-down approach from central governments. Such a paradigm of implementation usually results in the non-use of the deployed technologies and their associated e-services. A consequence of non-use of e-services results in a wastage of the public fiscus. The extant literature points to a number of underlying causes of the problem. One such problem which has been highlighted is called the “Design-Reality gap”. This paper investigates the nature of the gap. It presents findings from policy analysis and in-depth face-to-face interviews with e-government policy makers and implementers. In addition, it reports on findings from focus group discussions with potential e-government users in a health sector setting. The results which are based on a participatory action research methodology, reveal that there exists a glaring design-reality gap between e-government policy planners and citizens’ aspirations. The authors argue that co-creation could be a feasible approach for the design of e-government application services towards efforts to bridge the design-reality gap.

“Megaproject complexity attributes and competences: lessons from IT and construction projects” is the fourth article and is authored by Maxwell Nyarirangwe and Oluwayomi. K. Babatunde. Megaprojects have been associated with persistent underperformance technically, financially, socially and environmentally. This underperformance has been attributed to the inherent complexity attributes and the gaps in the form of the mismatch in the project management competences and processes used by the project management teams to deal with the complexity attributes. This study seeks to investigate the performance implications of these complexity attributes to recommend suitable management competences for the successful delivery of megaprojects. This conceptual study used an integrative literature review to analyze and synthesize findings from existing scientific articles related to the complexity constructs based on a comparative assessment of Information Technology (IT) and construction megaprojects. The Complex Adaptive Systems (CAS) Theory was also used to highlight some of the factors that influence megaproject performance towards identifying suitable management processes and competences, which are required to deal with megaprojects complexity. The key findings include a nomenclature of the main complexity attributes, their implications on the performance of IT and construction megaprojects, and, lastly, the management competences and processes that are required to deal with the complexity attributes for improved megaproject performance.

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 special issue editors,

Sam Takavarasha Jr, *University of Fort Hare, South Africa*

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An interpretive study on the role of top managers in enterprise resource planning (ERP) business value creation

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An interpretive study on the role of top managers in enterprise resource planning (ERP) business value creation

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Abstract:

This paper contributes to the growing body of literature on enterprise resource planning (ERP) business value by investigating organizational ERP development in view of the active involvement, vision, and direction of top management teams (TMTs). A top-down approach to ERP adoption and implementation was adopted with socio-material and social construction assumptions about the mechanisms that generate ERP business value. A single ERP case study was analyzed in an industrial setting by interpretive means, thus providing theoretically based, detailed and interesting insights. Our research suggests that ERP benefits emerge during the TMT's encounters with the ERP system through pragmatic action and situated improvisations. Our findings suggest that ERP adoption is strongly influenced by TMT characteristics and social processes, while complementary process-change needs are perceived by the executive participation during implementation. We also suggest that when the ERP system goes live, a synergistic relationship termed TMT-IT imbrication will create the technological infrastructure perceived as ERP value. At this post-implementation stage, various TMT characteristics and processes are proposed that greatly influence top managers' patterns of imbrication behavior. Several propositions are developed and summarized in a framework to enhance the current understanding of managerial agency in achieving business benefits from ERP systems. The paper concludes with implications for top managers and future research directions.

Keywords:

ERP; managerial agency; affordances; imbrication; interpretive; case study.

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1. Introduction

The topic of enterprise resource planning (ERP) systems is interesting and important in theory and practice because organizations have invested and continue to invest in enterprise systems to gain access to powerful computer-based information systems (IS) in a more cost-effective manner than through in-house software development [1]. As ERP systems affect many aspects of an organization's internal and external operations, their successful deployment and use are critical to organizational performance and survival [2]. However, implementation is not a procedure of unproblematic installation but rather a complex socio-technical process of renegotiation and redevelopment [3]. Indeed, approximately one-half of ERP implementations fail to meet the organization's expectations [4, 5], and most accounts of ERP failures are linked to lack of top management support (TMS) [6-11]. Therefore, for an adopting organization, the key issue concerning enterprise systems such as ERPs is the critical factors explaining the success of the implementation [8, 12, 13]. Initially, the organizational use of information technologies (IT) was the responsibility of IT specialists, departments or functions. Later, IT research suggested that the responsibility for IT management should be shared between IT professionals and line managers [14-17]. Hence, business managers should deploy IT effectively by assuming ownership and leadership of IT projects within their areas of responsibility [18]. Moreover, past research has shown that TMS, i.e., understanding the importance of IT, sponsoring initiatives of IT personnel and participating in IT project activities [19], is an extremely important organizational factor for successful IS planning [20, 21], successful IS implementation [22-24] and its contribution to performance [19, 25, 26]. Particularly, in the case of ERP systems, the active involvement, vision, and direction of top management teams (TMTs) provide the impetus needed to sustain the implementation process [27]. However, studies on ERP's critical success factors [28, 29] and studies on ERP's effects and risks [30, 31] offer few insights beyond conventional wisdom, and many lack theoretical explanations that adequately explain why the outcomes occur as they do and the way in which findings are reported [32, 33]. Thus, although many studies identified TMS as a critical success factor for ERP implementation [e.g., 7, 34], we lack understanding of how and why TMS contributes to ERP success [35]. Details on the requirements of TMS are provided in the project phase [see 9] and are also acknowledged during the post-rollout period [see 34]. However, the research reported in this paper examines managerial agency through the entire ERP life cycle while also directly engaging issues central to organizational theory, materiality and power, which have hitherto been downplayed in an attempt to counteract the field's earlier tendency toward technological determinism [36].

On the other hand, the IS value generation process still needs to be elucidated because this research stream is heavily dominated by the adoption of variance theories in contrast to process theories [37]. Therefore, an emergent perspective between top managers and IS could substantially illuminate the nature of IS business value. In the attempt to theorize an emergent view of top managers' participation in ERP business value in an IT-intensive world, the socio-material approach may be useful. Against this backdrop, we adopt the theoretical lens of affordances [38] and the imbrication perspective [39] to fundamentally challenge and advance scholars' understanding of the role of top managers in ERP business value creation. Technology affordances and constraints theory is appealing to construct post-hoc explanations of behaviors and outcomes in individual case studies [40], but it can also be viewed as a promising means of analyzing and researching the technology appropriation process [41-43]. Accordingly, we capture the interplay between the ERP system and the TMT using the concept of 'affordances', which is a useful approach to explaining the ever-more-symbiotic relationship between IT and organization. Although the affordance theory landed with delay in the IS field, attention to it is rapidly increasing [44-47]. For example, Anaya [48] delivers a discussion about how sociomateriality can enhance the understanding of benefits realization from enterprise systems, suggesting that benefits can be achieved by using organizational capabilities to exploit the technological possibilities of these systems. This paper adds to these incipient studies but addresses the following research question: how and why does managerial agency influence the business benefits achieved from ERP systems during the adoption, project and post-implementation phases?

The case study reported in this paper has been carried out in an industrial setting using interpretive research. Our findings suggest that ERP adoption is strongly influenced by TMT members' background, goals and social processes, while the TMT participating in ERP implementation greatly determines complementary process change needs. We also suggest that when the ERP system goes live, a synergistic relationship termed TMT-IT imbrication will create the

technological infrastructure that will be perceived by the TMT as ERP value at the intermediate process level. Managerial IT competence and the implementation efforts made by top managers, managers' goals and functional position, and the presence of imbrication factions may greatly influence managers' perception of ERP value.

From one point of view, ERP packages have profound effects on the structuring of work and the forms of human action they enable or constrain [49], thus privileging material agency. Conversely, ERP systems can be resisted and reinvented during use [50], thus favoring a human agency view. However, our use of affordance theory was based on our increasing interest in this theory as a specific way of conceptualizing what a TMT with a particular purpose can potentially do with a technology such as an ERP system. As relational concepts, affordances and constraints may facilitate the scholarly understanding that what one TMT with particular capabilities and purposes can or cannot do with an ERP system may be very different from what a different TMT can do with the same technology. Although the claim that the TMT should be more actively involved in obtaining IT value is not new [see, e.g., 51, 52-54], surely the newness of this paper lies in its ontological stance that contributes to the unpacking of how exactly the TMT should be actively involved in obtaining ERP value. Furthermore, although imbrication is not unique to the TMT and is valid to anybody in an organization, –i.e., by paying attention to ERP affordances and constraints, employees can form routines in carrying out their daily work, and those routines may contribute to ERP value creation–, we suggest that obtaining ERP business value, according to business strategy and objectives, entails TMT-IT imbrication.

The structure of the paper is as follows. First, we bring together the insightful theory stimulating this study. Second, we describe the setting up and carrying out of the fieldwork of our interpretive study. Third, we explain the empirical findings corresponding to the stages of the ES journey, while stating the diverse local constructions encountered in the form of theoretical propositions. Finally, we illustrate a collective synthesis of our empirical findings in a framework and discuss theoretical and practical implications, study limitations, and future research directions.

2. Background

The complexity and multidimensionality of the process of IT value creation constitute a great challenge for researchers [55]. Because it is difficult to fully capture, allocate, and isolate the value generated by IT investments, perceptions play a key role in assessing the impact of IT [56, 57]. Previous research on IT value has highlighted the complementarity argument, i.e., IT factors and non-IT factors must be integrated to achieve business goals [58, 59]. IT is not simply a tool for automating existing processes but, more importantly, is also an enabler of organizational change that can lead to additional productivity gains [60]. These arguments are supported by many theoretical lenses, including the sociomaterial perspective [61-63] and the notion of affordances as an influential ecological psychology theory [38, 64]. Technology affordances and constraints theory is increasingly used to understand the uses and consequences of IS [40]. An affordance perspective suggests that although IT and organization features may exist separately, their value in explaining organizational form and function is derived from how they are enacted together [43]. Therefore, technology affordances and constraints are distinct from both technology features –i.e., properties or built-in functionalities– and human purposes. Indeed, they help explain that (i) people do not always realize the apparent potential of a technology when they use it; and (ii) people sometimes or often use technology in ways that designers never intended [40]. In particular, the relational concept illustrates how new uses or new benefits from ERP systems are not inherent in their material properties but rather largely based on the dynamic relationship between people experiencing their agency by adapting these systems to fit their needs and the materiality of the ERP system [48]. Whereas ERP systems favor, shape, or invite, but at the same time constrain, a set of specific uses, these systems can lead to different practices depending on the organizational context [43].

By and large, TMS has been an organizational factor emphasized by researchers as necessary to taking full advantage of IT [65-69], as an informal but effective IT governance mechanism for IT-business alignment and collaboration and, thus, for improving IT business value [70]. Powerful actors shape how people use the technology and how particular uses are diffused across the organization [71]. Likewise, for ERP benefits, TMS is a crucial success factor [7, 67, 72, 73]. Consequently, we address the issue of ERP business value by adopting the imbrication perspective [39] and by

focusing on the role of top managers as the crucial social agency–non-IT factor–and key complementary resource for the IT value-creation process.

Technology affordances and constraints theory considers the dynamic and non-deterministic interactions between people and organizations and the technologies they use. Some scholars assert that technology is inseparable from the ways in which people and organizations use it [e.g., 61]. Then, they refer to ‘technology-in-use’ and consider their distinction analytical only. Conversely, others accept an ontological distinction between technology and individual or social practices, i.e., that technologies have features and functionalities regardless of whether humans recognize or use them. However, they acknowledge that technology and social practices are tightly intertwined in a way that is sometimes called ‘imbrication’ [40]. Leonardi [39] elaborated on the theory of affordances to develop his imbrication perspective, suggesting that coordinated human agencies–i.e., social agency–and the actions that the materiality of a technology allow people to engage in–i.e., material agency–become interlocked in sequences that produce the empirical phenomena called ‘organizations’ and ‘technologies’, respectively. Both agencies represent capacities for action, but they differ with respect to intentionality. Thus, people have intentionality, and technological artifacts have materiality [74]. ERP packages are especially relevant in influencing human agency at work by proactively stipulating the steps that must be followed for a transaction to be properly executed. That is, ERP packages have profound effects on the structuring of work and the forms of human action they enable or constrain [49]. A relational view of affordance goes beyond talking about generic users or technology as bundles of features. Here, a user’s goals and abilities, social context and the specifics of the situation will matter very much [75]. Managerial IT competence allows exhibiting IT leadership [76] and may affect top managers’ perceptions and behaviors regarding IT initiatives [77].

As noted by Walsham [78], theory–in our case affordances and imbrication–inspired and enabled us to gain good insights from field data. In this paper, the concepts of ‘affordance’ and ‘constraint’ have been concretely examined for ERP systems and the case study setting.

3. Study design and method

The case study described in this paper concerns the introduction of a new SAP/R3 ERP system into a manufacturing company. The planned system was complex and impacted all major areas of the organization. Single-case studies are eminently justifiable when the case may be ‘representative’ or typical [79]. In that sense, this case represents a typical ERP project but in the presence of the essential IT involvement of most of the TMT members. Three subunits of analysis were considered: the organization, the TMT and each TMT member individually. We thus conducted our research on an embedded, single-case study relying on an interpretive, constructivist view of the research process. Therefore, the organizational processes that concerned how to obtain ERP value, as specified by emergent process theories, were examined by means of interpretive methods and considered in relation to the influences of earlier phases. Keeping in mind the assumptions of interpretive research [80, 81], we focused on the subjective descriptions of top managers’ practices and their perceived IT affordances, constraints and value concerning the ERP software package.

Concerning the role of theory in interpretive research [82], we used emergent process theories [12, 83] about how to obtain IT value; we also used affordances [38, 64] and the imbrication perspective [39] as valuable initial guides to design and data collection. However, we preserved a considerable degree of openness to the field data [84] and a willingness to expand initial assumptions and theories by the iterative process of data collection and analysis.

The data collection, involving contact with the organization, occurred over a three-month period between October and December 2013. Multiple methods of data collection were employed, including interviews, company documents, participant observations and surveys to the TMT members. However, the main research method involved semi-structured interviews. One of the authors of this study collected the bulk of our data by conducting interviews with several managers using an evolving protocol [see 85]. In addition to direct observations, we also used company documents, e-mails, and informal interviews to triangulate our findings. Additionally, we surveyed managers to obtain data on perceived IT value and managerial IT competence. Surveys can be a useful complement to other data sources and are thus perfectly valid inputs for an interpretive study [78].

The methodological rigor of the case study may be judged in terms of credibility, transferability, dependability, and confirmability [86]. To first ensure credibility, we applied the following techniques: prolonged engagement, persistent observation, triangulation of sources, methods and theories, peer debriefing, and member checking. The second author impartially examined the first author's transcripts, notes, reports and methodology on a regular basis. After that, feedback about vague descriptions, understated points, data errors, biases or assumptions made by the first researcher was provided to enhance credibility. The results were shared, discussed and validated by the respondents. Data collection methods and sources were triangulated, and rival explanations were considered. Transferability was assured by a thick description [87] of the context so that the reader can determine whether the findings may possibly apply to another setting. Dependability and confirmability were ensured by fully documenting the research process and results. In this regard, an interview guide, a case documentation, and a data analysis protocol were elaborated. Furthermore, the second author was the designated person to check for consistency, thus reviewing the inquiry process, data, interpretations and recommendations [88]. Precautions were taken to corroborate the interpretations made [79, 89]. The design and conduct of this study followed the principles of methodological triangulation [90] and expert guidelines for each method individually [e. g., 78, 82, 85, 91]. Emerging concepts were checked for representativeness by examining them across participants and with multiple methods. Triangulation across data sources—multiple informants at different functional positions—and across data collection methods—interviews, documentation, observation, and surveys—further served to strengthen the emerging concepts. Finally, the interviewees provided commentary, correction, and elaboration on drafts of the findings. Following Walsham's [82] suggestions on what should be reported to ensure rigor and validity in an interpretive case study, a summary of the specifics of site selection and description, data sources and analysis are provided in the following paragraphs.

3.1. Site selection and description

Theories on how to obtain ERP value suggest studying the entire emergent process from adoption to success [12]. Affordance theory suggests the study of TMT's competencies, goals, perceived affordances and constraints using the ERP system. Then, we had to study TMT's characteristics and processes in appropriate settings not only where top managers were supporting IT initiatives but also where the TMT's size was appropriate, including at least five members [92]. Moreover, where a complete working solution was likely to be adopted and used—a situation that relied on ERP's technical adequacy, i.e., its functionality, ease of use and learning, reliability, availability of good technical and support infrastructures, etc.—. We launched two email campaigns targeting companies matching our TMT's size criteria. The tracking issues resulted in more than one hundred conversations. Finally, the firm SHOWERSCREEN (a pseudonym) was chosen because it completely matched all our requirements.

SHOWERSCREEN is a Spanish producer of shower cabins and screens or doors. The company was founded in 1989 as a small family-owned firm. In 2012, with a relatively new senior management team, the firm started the internationalization process with revenue of 21 million euros, 174 employees and 7 TMT members: deputy Chief Executive Officer (deputy CEO), CFO (financial), COO (operations), CMO (marketing), KAM (sales), ORM (organization), and HRM (personnel). At the time of the study, the company had branches in four countries and was preparing for entrance into two new countries. The organization can be described as having a centralized functional structure, power-oriented culture, and congruent goals and values regarding IT. The firm's CEO promoted a data-oriented culture and inspired action based on insights from data. All TMT members were highly committed to IT as an operational and strategic asset. Although we observed the crucial role played by the CIO (not a TMT member), sound IT leadership was attached to the role of the deputy CEO. However, almost all the TMT members had extensive skills for interpreting the meaning of the ERP data elements, their relations and limitations for analysis. Moreover, they showed strong interpersonal skills to champion, train and support end users in their respective areas.

3.2. Data sources

We followed specific guidelines for the conduct of semi-structured interviews [85], including preparing the script, minimizing social dissonance, flexibility, improvisation, and openness. The semi-structured script included questions about IT investments, IT impacts, top managers' characteristics, and organizational and environmental characteristics. All the questions were informed by the theories in what we grounded our research, such as how to create IT and ERP value [12, 83], affordances [38, 64], and imbrication [39]. Top managers were interviewed individually in one session that lasted one and a half to two hours in length.

A major source of data on TMT's perceived IT value and characteristics was obtained by an internet survey built following Dillman's [91] suggestions that was administered to the entire TMT immediately after the interviews. The major variables measured by the questionnaire items were IT perceived value, adapted from Tallon's scale [57], and TMT's IT competence, adapted from Bassellier's et al. validated instrument [93]. Both scales were translated from English to Spanish with minimum adaptation.

Additionally, we also obtained data from interviews with the CEO and CIO. The CEO gave us valuable information about strategic and IT vision, the status of the ERP project and his personal commitment to IT. The CIO informed us of the main details in the development of the ERP project, the reasons for initiating the project and whether top managers were really involved and participating in the project. Additionally, documents pertinent to the project and the organization were sought, reviewed and analyzed for another perspective on the data. These documents included external communication documents, documents on the firm's activities and products, project documentation, and documentation from the ERP supplier and the specific SAP/R3 solution.

3.3. Data analysis

We used simple descriptive statistics—percentages—of quantitative data from surveys only to illustrate the IT competence level of TMT members and their perceived IT value. Instead, we explored all the qualitative data—interviews, documents, etc.—using content analysis [88]. This process entails five steps: unitizing the interview data, coding the units, identifying the categories of similar units, noting the emerging themes, and subdividing themes into subthemes. Following recommendations on the use of computer-assisted qualitative data analysis software [94, 95], we recorded the interviews and selected Dedoose to process and analyze the data from the survey and from the interviews. We chose this tool because it was specifically designed and built for analyzing qualitative and quantitative data. We excerpted and coded each interview file. For the first cycle of coding, we used structural, descriptive, "in vivo", value and magnitude coding. Code weights or ratings represented quality, sentiment, importance or any other dimension on a number ranging from 1 to 5 to help distinguish variation in content where the same code has been applied to many excerpts. Subsequently, we used pattern matching and axial coding [see 96]. Thus, our analysis involved interpreting the meaning of data elements grounded in inductive pattern recognition [89]. What follows is an example that shows how we coded several conversations regarding the analysis of IT investments. Codes and weights appear in this way—code1, weight1; code2, weight2; ...—:

Deputy CEO: *"These investments in the short-term will not have a significant effect in streamlining processes, but rather, quite the contrary—short term ERP intermediate impact, 2—; however, it is a tool with enough potential to allow us to work more efficiently—affordances, 4; efficiency, 4—; but you have to believe in that, you cannot make those decisions based on data ... It is very difficult quantifying it [referring to SAP] in terms of profitability, very difficult—ERP investment analysis, 1—"*.

CIO: *"In this case it is very complicated [referring to SAP]; the main reasons [to make the investment] were the limitations for growing and the lack of information consistency—legacy systems, 1; impeding growing, 4; data inconsistencies, 4—"*—ERP investment analysis, 1—.

ORM: "We are highly committed—commitment, 5– and capable enough to do it. Then, come on!—TMT involvement, 5—"—ERP investment analysis, 1–.

KAM [regarding the sales app]: "We did not take into account any budget for the investment, or profitability issues—ERP investment analysis, 1–; just improving the inbound flow of commercial information—affordances, 4; improving frontline sales reps' work, 4–, as well as [the improvement] of tracking and control activities—affordances, 4; improving sales reps control, 4–."

Most often, our respondents did not respond to our questions explicitly in terms of affordances, constraints, participation, or use; however, we inferred the responses' implicit meanings from our interpretation surrounding the development and use of the ERP system and from their behavior deduced via observation, documentary and verbal data. For example, we depict TMT-IT imbrication based on our interpretation of the interviews, according to top managers' extreme ratings for each dimension.

4. Findings

Although each ERP system experience runs a different course, the empirical findings serve as a credible representation of the various local constructions encountered, which can adequately enlarge the understandings of respondents while serving the purpose of the inquiry [97]. The different local constructions encountered have been explicitly stated in the form of theoretical propositions and should be considered as explanations for particular phenomena derived from empirical interpretive research in specific settings that may be valuable to other organizations and contexts in the future [82]. Findings are presented corresponding to the phases of the ERP journey and summarized in advanced in Table 1.

Table 1. Phases, main concerns and empirical observations

Phase/Concern	Observation	Method/s	Data sources
Chartering phase			
Whether,	Yes.	Interviews.	CEO, Deputy CEO, COO, ORM, and CIO.
why,	Many constraints related to their legacy system; Many perceived affordances in the new system.	Interviews.	CEO, Deputy CEO, CMO, ORM, and CIO.
and how to undertake the ERP system investment.	"Big-bang" implementation, in-house with external assistance.	Interviews, observation.	Deputy CEO, ORM, CIO and project documents.
TMT's goals.	Automation, integration, analytical decision making, enhancing customer relationship management, etc.	Interviews.	Deputy CEO, CFO, COO, CMO, KAM, ORM, HRM.
Social processes.	Power and contagion may cause the convergence of attitudes, values, and beliefs among the TMT members.	Interviews.	Deputy CEO, CFO, COO, CMO, KAM, ORM, HRM.

Phase/Concern	Observation	Method/s	Data sources
Project phase			
Configuration–parameter settings–.	High.	Interviews, observations.	Deputy CEO, CFO, COO, CIO, and project documents.
Customization–addition of non-standard features–.	High level of IT tailoring to fit crucial processes, especially in operations management.	Interviews, observations.	COO, CIO, and project documents.
Process change.	Low process change. High adaptation to the ERP built-in processes.	Interviews.	Deputy CEO, CFO, HRM.
Success in terms of the implementation project.	Classic performance project metrics were quite successful.	Interviews, observations.	Deputy CEO, CFO, COO and project documents.
Shakedown phase			
New initiatives.	New system’s affordances perceived: order tracking, e-commerce and business intelligence.	Interviews, observations.	CEO, Deputy CEO, COO, CFO, CIO and IT function’s to-do list.
TMT’s IT competence.	Medium.	Interviews and surveys.	CEO, Deputy CEO, CFO, COO, CMO, KAM, ORM, HRM, and CIO.
TMT’s perceived ERP value.	High.	Interviews and surveys.	Deputy CEO, CFO, COO, CMO, KAM, ORM, and HRM.

4.1. Chartering the ERP investment

SHOWERSCREEN’s top managers decided that it was time to invest in a new ERP solution because they had identified many deficiencies and obsolescences related to the legacy system. The new SAP R/3 system was the most important IT investment ever made and had cost over 1 million euros. Top managers were key players in the decisions leading up to the funding of this crucial IT investment and narrowed the field of ERP vendors to three leading candidates. Because the deputy CEO and the CFO had previous experience with certain SAP partners and with this system, they opted for SAP/R3. Although objectives and metrics were left undefined, we observed a high degree of information exchange, consensus and shared vision about the role that IT should play in the organization. Several managers justified the complexity when trying to analyze the viability of the ERP investment. For example, the deputy CEO stated, “*In the short run, these investments will not have a significant impact on process level agility; indeed, it is most likely the contrary. However, the tool [referring to SAP R/3] has enough potential to make us work efficiently, but you have to believe in that because you cannot make these decisions in a rational manner based on data [...]; it is very difficult evaluating these investments in terms of profitability*”. Moreover, the CIO said: “*In this case [referring to SAP R/3], it is very complicated, but the main reasons leading to the investment were the limits for growing and the data inconsistencies [related to the legacy system]*”. Notably, the professed objective of the project was not a specific business or process goal but rather to employ the new system to replace legacy systems that were stretched to the limit by 2011 and perceived as a barrier to future expansion. TMT members perceived many affordances in the new system

related to issues such as automation, data rationalization, customer-facing processes, service and customer retention, ease of expansion and growth, and better decision making. Additionally, the deputy CEO said that it “*was an opportunity to invest in something really valuable in the long term*”.

In view of affordance theory, the ERP package has material properties that afford different possibilities for action within SHOWERSCREEN’s specific context, e.g., automation, reliability, integration, etc. Therefore, affordances are unique to the particular ways in which the TMT perceives what SAP/R3 does. Because TMT members using SAP/R3 have diverse goals—e.g., analytical decision making or enhancing customer relationship management—, they perceive the system as affording distinct possibilities for action. Hence, the TMT members’ goals when deciding to adopt the ERP system are formulated, basically, by their perceptions of what SAP/R3 can or cannot do, and those perceptions are shaped by the TMT’s goals. Likewise, the TMT members perceive the legacy system’s deficiencies—e.g., obsolescence, lack of technical support, and lack of scalability—as constraining their ability to achieve their goals.

Proposition 1: In the chartering phase, TMT members draw on familiar schemas or frames to make sense of the affordances and constraints of the new ERP system, thus transferring interpretations from past practice or experiences to present ones. Moreover,

Proposition 2: In the chartering phase, TMT members actively construct perceptual affordances and constraints when attempting to reconcile their own goals with the ERP materiality.

However, why do TMT members come to share similar perceptions of the previous legacy system’s constraints and the new ERP’s affordances? Perceptions largely determine whether and why they will adopt and use the new ERP system. From a constructivist point of view, social construction, social influence processes, social perception, and power all play a role in shaping perceptions of the ERP system’s utility. In this view, the exposure to others’ attitudes through membership in a group shapes peoples’ perceptions of a new technology [98]. Thus, adoption is a collective rather than an individual process that stands apart and may sometimes be divorced from the technology’s physical capabilities [36]. Social forces would be more important than the technology’s physical attributes in determining use [99]. In our study, various social processes came into play and became entwined with the technology’s materiality within the context in which it will be used [41].

Proposition 3: In the chartering phase, the perception of affordances and constraints of the new ERP system occurs through the convergence of attitudes, values, and beliefs among the TMT members. Power and contagion are the primary cause of convergence, favoring the adoption of an ERP system.

4.2. The ERP project

The project phase comprises activities that aim to get the system up and running in all the organizational units: finance, operations, manufacturing, marketing, sales, etc. Generally speaking, obtaining IT value requires two necessary outcomes: (i) obtaining IT assets from the correct IT investments via IT management practices and (ii) obtaining IT impacts by using IT assets properly [83]. In the specific case of ERPs, they hold deep knowledge of common best practices for business but are generic, semi-finished products that adopters must tailor to the organization’s needs. One of the main problems in implementing ESs is determining which mix of configuration (i.e., parameter settings), customization, (i.e., addition of non-standard features), and process change is the best to meet project or business goals [100, 101] because those systems impose their own logic on the company’s strategy, culture and organization, demanding organizational discipline and strict adherence to standardized processes [49, 102]. These systems are often promoted as a means of transferring best practices and might be considered “*a technological architecture that actually dictates how processes should be undertaken*” [103:3]. Consequently, obtaining the IT asset is mainly a process of molding and adapting the so-called best practices to fit the critical processes of the adopting organization [104, 105]. However, the adopters of an ES often adjust the organization’s work system to fit the built-in features of the package [12]. Implementing an ERP system establishes a tight link between organizational structures and business processes within the ever-shifting IT framework [106]. Consequently, these organizations must commit to some degree of business process reengineering.

SHOWERSCREEN's top managers made an explicit decision to deemphasize process reengineering in favor of the successful implementation of existing processes. A 'big-bang' risk implementation was chosen to anticipate the end of the system's installation. As the deputy CEO stated, "*process redesign was actually minimized and lesser than I would have desired; people refused to change their routines; however, they finally understood that SAP/R3 embodies certain aspects that require adaptation*". Each phase of the project was carefully planned, and ongoing changes were resisted. New system implementation was completed in no more than twelve months as the firm optimized the entire manufacturing process, including production planning, compliance, and supply chain management and also empowered account managers with enhanced CRM mobile solutions. Therefore, modifications were not minimized because the system was specifically adapted to fit the COO's goals and needs. We observed an important level of adaptation to the ERP built-in processes but also an elevated level of IT tailoring to fit crucial processes of the organization, especially in operations management. Based on our observations, classic performance project metrics were quite successful against the planned schedule, budget, and functional scope.

In view of the imbrication perspective, and thus depending on whether the TMT members perceive that the ERP system affords or constrains their goals, they make choices about how they will imbricate agencies. If the TMT members perceive that SAP/R3 affords possibilities for action, then they most likely will change their patterns of ERP usage, e.g., by adapting to SAP/R3 embedded financial capabilities. Conversely, if they perceive that the ERP constrains their goals, they will change the ERP system, e.g., by tailoring the SAP/R3 operations module to meet their requirements. TMT members who have the authority to acquire the new ERP and who control the implementation terms may frame the ERP's utility and mandate that it should be used in ways that replicate the status quo and that change those other aspects that they believe need to be changed [107]. This perspective connects implementation and use with preceding decisions and events in the chartering phase.

Proposition 4: In the project phase, perceived ERP's affordances and constraints by TMT members may frame current and future process-change needs. That is, potential ERP value at the intermediate process level fundamentally depends on TMT members more closely participating in configuration, customization and process-change activities.

4.3. Shakedown

In the chartering phase, top managers' activity was concentrated on identifying and selecting the appropriate ERP software package, approving and funding an initial ERP journey, and communicating the potential benefits to gain commitment from all stakeholders. Next, in the project stage, top managers were focused on supporting the chosen ERP modules and implementation strategy, assigning project teams and training courses, and identifying current and future needs of process change in accordance with the overall goals and the organizational context. Generally, in the shakedown stage, top managers are expected to engage in tuning system performance, retraining activities and encouraging all stakeholders to maintain a positive attitude towards the ERP system and its future benefits [108]. Past research has conceptualized all these previous actions as TMS [see e.g., 25, 109].

As expected, many errors and problems occurred after the installation was finished. The COO argued: "*we are still putting out diverse fires [referred to SAP]*", i.e., they have not achieved 'normal operation'. We observed that only two departments had already been placed into the new system: finance and operations. Indeed, the KAM said: "*I am still waiting for my turn, still using the legacy system when I create queries on historical data*". SHOWERSCREEN was working for two years with SAP R/3, and as the CEO stated, "*we still have 60% pending to accomplish SAP R/3 project goals*". However, substantial improvements in service processes have resulted and are visible both internally and externally. Hence, the analysis of the interviews reveals that in the interviewees' SAP R/3 project experience, SHOWERSCREEN is at the dawn of the shakedown stage.

Markus and Tanis' [12] four 'ideal' phases of the ES experience describe the process of achieving ERP business value as a series of four linked and necessary conditions that are assumed to be insufficient but necessary for the outcome to occur [110]. However, our empirical results show that SHOWERSCREEN's TMT members perceive significant IT value without having accomplished the mandatory previous processes or stages. Why does this happen?

4.3.1. Perceived ERP value

We observed that SHOWERSCREEN’s top managers perceived high ERP value—from interviews 70%=3.5/5 and from surveys 74%; see Table 2 and 3, respectively—regarding impacts at both the intermediate process level and organization-wide level in aspects such as branding—which was mentioned 5 times in the conversations and was pondered 3.6 by interviewers on average using a magnitude scale ranging from 1 to 5; see Table 3—, communication, control, differentiation, efficiency, customer reliability, flexibility, and analytical decision making. Mostly, they perceived high ERP value in enabling differentiation, efficiency, control, flexibility and reliability.

Table 2. Top managers’ perceived ERP value based on interview analysis

IT value expression	Count	Min	Max	Mean	Median
Branding	5	3	4	3.6	4
Communication	7	1	4	3.1	4
Control	15	3	5	4.1	4
Decision making	16	1	5	3.6	4
Differentiation	7	3	5	4	4
Efficiency	25	3	5	4	4
Flexibility	5	4	5	4.2	4
Innovation	3	1	4	2.7	3
Process redesign	1	2	2	2	2
Reliability	14	3	5	4	4
Sales increase	4	1	4	2.8	3
Total	102	1	5	3.5	4

Magnitude coding scale ranging from 1 to 5

The deputy CEO experienced three SAP projects in industrial settings in past positions. In this project, for example, he perceived affordances in breaking down the silos of customer information located in the back office and sharing that information with frontline sales reps through their mobile devices. Now, account managers have been empowered with the information they need to nurture each opportunity. Another perceived affordance was related to customer order tracking. Accordingly, a web service was developed that provides information about current orders and their positions in the manufacturing process. Moreover, supporting videos and instructions addressing customers’ needs are available on the website. Furthermore, top managers produced an online catalogue, i.e., a virtual setting that allows customers to create their own budget by choosing between different layouts, colors, materials, etc. This setting will boost new ecommerce actions. Additionally, they improved call center management and tracking performance, and they also ensured an optimal customer service experience.

Previous examples show that the deputy CEO pays substantial attention to the possibilities for action due to the new SAP/R3 functionality, including call center operations, CRM, and e-commerce storefronts. As a result, SAP/R3 has been adjusted to fit the TMT’s goals and intentions. All these changes create the infrastructure that people use to get their jobs done. Indeed, previous arguments show that the deputy CEO is highly involved and actively participates in the resource provision and structural arrangements needed for the SAP/R3 implementation and use. He also participates in the interface design of mobile apps for account managers to improve usability and, hence, reduce barriers to use.

The deputy CEO’s IT vision mainly focuses on using IT for improved decision making and increased sales revenue, which agrees with the CEO’s view. As the deputy CEO said, “our CEO believes in professionalism, analytical decision making, digitalization, [...] and he is positive and permeable for IT projects”. The deputy CEO considers that the

introduction of SAP/R3 is an opportunity to make process changes, but he recognizes that it triggers diverse and conflicting views among the TMT members. As previously mentioned, the business process redesign was not as extensive as desired. Because of the new affordances perceived by the TMT members in the shakedown stage, the company launched new initiatives around the SAP R/3 system, such as order tracking, e-commerce and business intelligence. As shown, SHOWERSREEN’s TMT members paid substantial attention to the possibilities for action due to the new SAP/R3 materiality.

Proposition 5: In the shakedown stage, the devoted and persistent TMT’s involvement in the ERP implementation and use—hereafter coined as TMT-IT imbrication—creates infrastructure in the form of routines and technologies that people use to carry out their work. TMT members perceive this infrastructure as ERP business value at the intermediate process level.

Proposition 6: In the shakedown phase, the TMT’s IT attention and use are needed to perceive ERP affordances and constraints, the catalyst for imbrication.

4.3.2. An attempt at the operationalization of TMT-IT imbrication

In this paper, we argue that the TMT should consider the potential benefits of ERP systems and how to obtain them, i.e., by changing routines or by molding the ERP system. However, an understanding of ERP potentialities can be achieved not only through continuous attention to ERP affordances and constraints but also through convenient use of the ERP system, as the realized benefits from enterprise systems emerge when people interweave with the system in practice to generate new uses for it [48]. Thus, to operationalize TMT-IT imbrication, we have added ‘attention’ and ‘use’ to the two dimensions of the TMS construct: involvement—subdivided into importance and personal relevance—and participation [25].

SHOWERSCREEN’s TMT members consider IT especially important (89.3%; see Table 3) and very personally relevant (75.0%), thus participating in IT activities (71.4%) while paying attention to ERP affordances and constraints (64.3%) when using the ERP system in their everyday working activities (71.4%).

Table 3. Top managers’ perceived ERP value, IT competence and imbrication

Top manager	Total perceived value	IT competence	TMT-IT imbrication dimensions					Total imbrication
			Importance	Personal relevance	Participation	Attention	Use	
Deputy CEO	82.2%	67.4%	4	4	4	4	3	95.0%
CFO	77.8%	68.0%	4	4	4	4	4	100.0%
COO	55.6%	31.4%	4	4	4	3	4	95.0%
CMO	66.7%	68.6%	4	4	4	4	4	100.0%
KAM	62.2%	38.9%	3	3	2	1	3	60.0%
ORM	95.6%	67.4%	3	1	1	1	1	35.0%
HRM	77.8%	54.3%	3	1	1	1	1	35.0%
Total	74.0%	56.6%	89.3%	75.0%	71.4%	64.3%	71.4%	74.3%

Dimensional scales of TMT-IT imbrications ranging from 1 to 4

As Figure 1 shows, we found three imbrication factions, i.e., subgroups comprised of TMT members who have similar imbrication patterns that differ from other subgroups of members. Four members are clustered around the high imbrication faction but show disparity between IT perceived values. The deputy CEO shows the highest perceived IT

value within the high imbrication fraction (82.2%; see Table 3) and holds a prominent level of managerial IT competence (67.4), particularly, valuable experience in adopting and implementing ERP systems. Conversely, the COO perceives the lowest IT value within the high imbrication fraction (55.6%) and records the lowest level of managerial IT competence (31.4%). Almost certainly, the COO views the new ERP implementation as a technology decision rather than a business decision, where the system in-progress benefits are not as large as those achieved with the previous legacy system. The COO experienced a high degree of ERP customization to replace the previous legacy system’s functionality, enduring the problems of both the project and shakedown phases. People will resist an application when the costs outweigh the benefits [received wisdom; see 111].

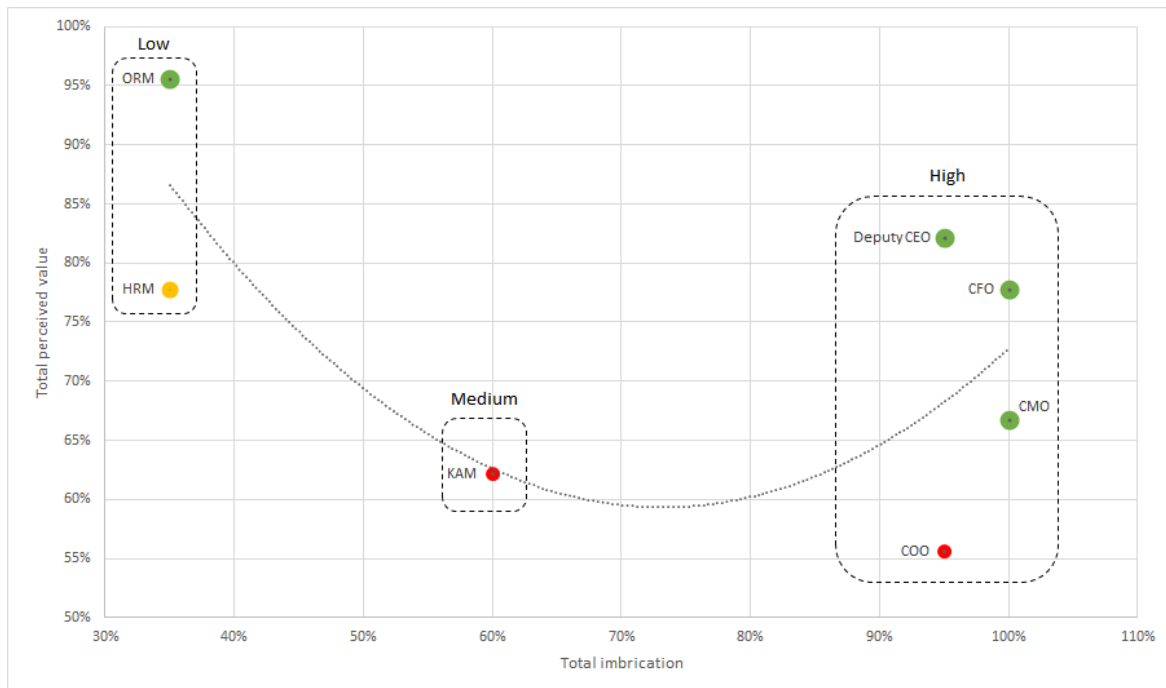


Figure 1. TMT-IT perceived value vs. TMT-IT imbrication, with the addition of managerial IT competence

Size and color—green, yellow and red for the smallest values—of data labels indicate managerial IT competence (see Table 3)

Otherwise, the KAM is the only member clustered around the medium imbrication faction. KAM’s goals are relatively low with respect to the new system, and he has not yet been impacted by the new ERP solution. Moreover, the KAM pays low attention to affordances and constraints and holds a low level of managerial IT competence. Finally, two members are clustered around the low imbrication faction. The ORM shows a particular commitment to IT, stating, “IT is important for every business” because “IT improves self-control and productivity” while claiming that “we are always trying to improve efficiency through IT”. The ORM is a long-tenured member who can explain every IT project previously carried out. He stated: “previous experience has shown us that we had to implement new IT quickly, diligently, and conscientiously”. Although he was a main actor in previous IT projects, he has become a guest in the SAP/R3 project. Similarly, the HRM exemplifies low imbrication but high perceived IT value. Notably, they support ERP initiatives because they consider the ERP system to be important for organizational goals. However, they do not pay much attention to the new ERP affordances and constraints.

Proposition 7: Top manager’s goals and functional position may determine his or her imbrication pattern—high, medium or low—. That is, high imbrication may be associated with top managers of functional positions related to the key areas covered by an ERP solution: finance, marketing, commerce, manufacturing, supply chain management, and service. Conversely, medium or low imbrication may be related to the marginal areas of an ERP solution, such as human resources management, sales, R&D, and sourcing and procurement.

Proposition 8: Within a particular imbrication pattern, managerial IT competence may have a positive influence on individually perceived ERP value, whereas the manager’s implementation efforts may have a negative influence on its own perception of ERP value.

Proposition 9: The presence of imbrication factions may have a negative influence on total TMT’s perceived ERP value. While highly imbricated TMT members create the ERP value that may be perceived by everyone in the organization, TMT members clustered around the low or medium imbrication factions are just supporting ERP initiatives but hardly generating ERP value. Therefore, the more TMT-IT imbrication, the more ERP value.

5. Discussion

Our aim of resolving how exactly top managers can create more organizational value with ERP systems was the theoretical challenge at the inception of this research. What follows is a collective synthesis of our empirical findings—summarized in Figure 2—embedded in the existing literature but also including theoretical and practical implications, study limitations, and future research directions.

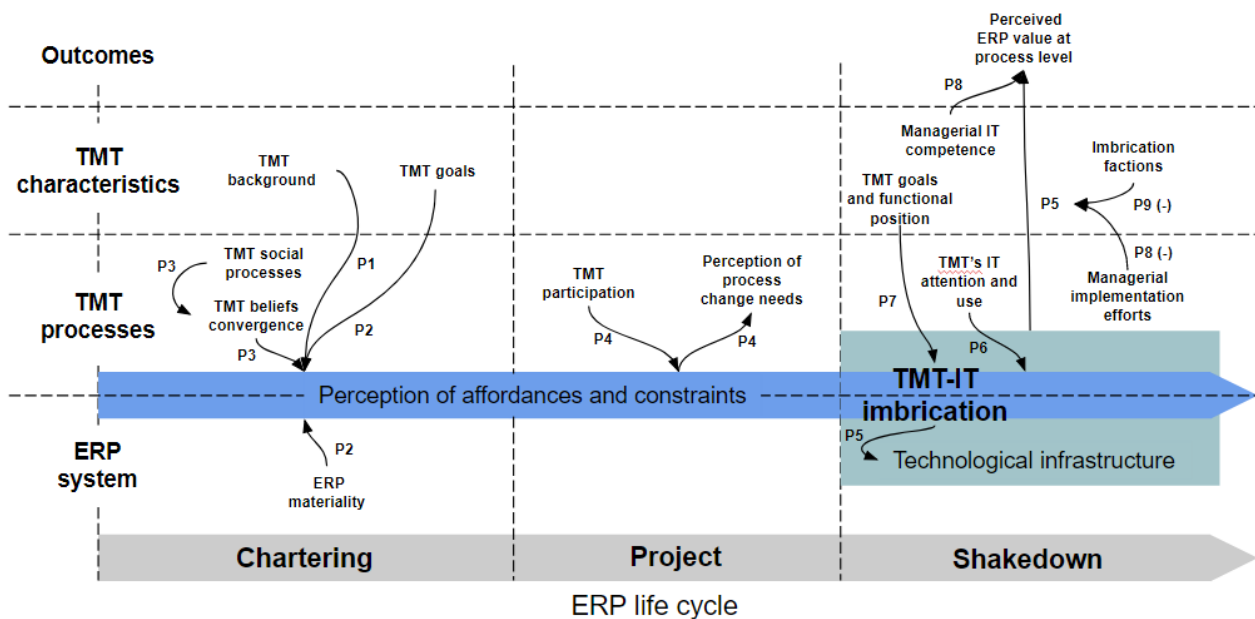


Figure 2. Research findings framework

In the chartering phase, TMT members make sense of the affordances and constraints of the new ERP system by both transferring interpretations from past practice and by actively constructing them when they attempt to reconcile their own goals with the ERP materiality. Power and contagion are the primary cause of convergence of attitudes, values, and beliefs among the TMT members, thus favoring the adoption of an ERP system. Largely, the technology acceptance model [112] provided a general explanation of the determinants of computer acceptance across a broad range of end-

user computing technologies and user populations. In contrast to the technology acceptance model and specific extensions that have been made for it in an ERP implementation environment [e.g., 113, 114], our results particularly show that, in the case of TMTs, social construction, social influence processes, social perception, and power play a crucial role in shaping perceptions of the ERP system's utility. Moreover, our interpretation of the results suggests that, in the project phase, perceived affordances and constraints by participative TMT members may frame current and future process change needs, thus delineating potential ERP benefits.

Furthermore, we interpret from our results that, in the shakedown phase, the TMT's devoted participation, called TMT-IT imbrication, creates the technological infrastructure, which is perceived by TMT members as ERP business value at the intermediate process level. At this stage, the TMT's attention and use are needed to perceive ERP affordances and constraints. Our results add to Anaya's work [48, 115], which provided a discussion of how sociomateriality can enrich the understanding of benefits realization from ES because benefits emerge after using the system and cannot be fully identified beforehand, when organizations are not completely aware of the system potentials, especially of the integration possibilities. Our results are also consistent with Hallikainen and Seethamraju [116], who explored the alignment of enterprise systems and organizations in the post-adoptive phase, focusing on the understanding of what managers actually do and how they interpret what they are supposed to do. In line with Jarvenpaa and Ives [25], who found that top managers with career backgrounds in output functions—i.e., marketing, sales, R&D—were typically more open to exploiting IS for competitive advantage, we suggest that top managers' goals and functional position may determine their imbrication pattern and thus the potential value that they might create. Moreover, we found that within a particular imbrication pattern, managerial IT competence may have a positive influence on perceived ERP value, while the manager's implementation efforts may have a negative influence on perceived ERP value; finally, the presence of imbrication factions may have a negative influence on total TMT's perceived ERP value.

A variety of techniques have been used to explore and extend ERP systems: business process management (BPM), workflow management, enterprise application integration (EAI), service-oriented architecture (SOA), grid computing, and enterprise architecture (EA), among others [117]. Precisely, at the core of EA lies the idea that IS and the business should be considered holistically and consistently [118] in order to drive the business benefits of IT [119-122]. The research reported in this paper is in line with the ideas of EA but also in agreement with Loonam et al. [123], who call for a more holistic approach to 'support' for organization-wide implementation while suggesting that top managers who foster a positive attitude toward IS can build a powerful coalition group to develop a vision aligned to the corporate strategy, thus creating organizational value.

We collected our data from only one organization. Therefore, we cannot claim that our findings have provided a complete overview of the issues surrounding TMT-IT imbrication in distinct types of ERP projects. Although we used multiple methods to triangulate our findings, we relied greatly on data from our interviews with top managers. Interviews with middle managers, users, IT staff members, and external consultants might have resulted in richer perspectives on our research topic. We hope that this interpretive study will promote additional qualitative and quantitative studies on the role of top managers in ERP value creation. Although many factors that we did not examine in this study are needed to fully capture potential ERP value, we have answered two important questions. First, *how* can top managers contribute to obtaining ERP value? In our view, they should establish a closer relationship with ERP systems and consider not only supporting ERP initiatives but also becoming involved in, participating in, attending to and using ERP solutions. However, we should be aware of the TMT's characteristics, such as functional position or top managers' goals or intentions, that can greatly influence imbrication with ERP systems. We suggest that top managers with high managerial IT competence levels are most suitable to create more ERP value for their organizations. Second, *why* do top managers play a role in obtaining ERP value? The answer to this question is because they perceive ERP systems as affording distinct possibilities for action or goal-oriented action [42]. However, top managers perceive ERP's affordances only when they pay attention to the ERP's materiality. In sum, this paper has offered practitioners a more complete path to obtaining value from ERP investments. Provisioning TMS is not enough. Hence, top managers should imbricate with ERP systems from the post-implementation stage. The TMT-IT imbrication multidimensional construct can be used in discussing, planning, tuning, and evaluating top managers' specific behavior with respect to ERP systems. Many practical questions may arise. For example, what if a company does not have a suitable TMT to imbricate with IT? What should they do? Make or buy it? We argue that a firm can hire top managers with high levels

of managerial IT competence; however, TMT-IT imbrication is path-dependent and requires time and effort, attention to IT affordances and constraints, and appropriate IT use. Therefore, it can be leveraged to create heterogeneous and imperfectly mobile resources and capabilities, thus building differential IT value.

In general, we believe that top managers' imbrication with ERP systems is a fruitful research area. This empirical research has left a number of questions unanswered. For example, how do institutional and technological contexts explain, shape, or inhibit various top management behaviors and actions? Moreover, quantitative studies may help to test the validity of the propositions. Future research needs to test the generalization of our findings and gain a better understanding of the conditions and mechanisms governing the effects of participation, involvement, attention and use over the progressive adoption of ERP systems in order to create more value in organizations. Future researchers need to study the differences between TMT-IT imbrication in diverse degrees of organizational centralization. As Jarvenpaa and Ives [25] noted, TMT's IT attention could be more tied to specific business needs in firms in which contact with IT function is more frequent and direct compared to highly decentralized or multi-business firms. Organizational size may also influence the role of top managers in obtaining ERP value [124]. Hands-on IT management might be much more important for small organizations, in which the CEO or TMT typically makes most of the key decisions and is the only person who can attach IT to corporate objectives and strategy [25]. Finally, longitudinal studies should test whether the imbrication process maintains the continuous commitment of the entire TMT, how IT leadership might change across distinct TMT members or along the phases in the ES life-cycle [125], and why this change may occur.

6. Conclusion

Research on ERP systems has called for the consideration of alternative theoretical assumptions regarding ERP implementation. In contrast to deterministic accounts of ERP journeys, we have examined the emergent four-phase process of enterprise systems implementation [12] with the support of the theoretical lens of the affordances and imbrication perspectives. As noted by Majchrzak and Markus [40], technology affordances and constraints theory might be appealing to those who aim to build theory, aim to interpret human and organizational technology-use behavior, aim to construct post-hoc explanations of behaviors and outcomes in individual case studies, or even to those who are interested in more precisely defining 'alignment' or 'fit' between people and technology. On the other hand, constructivist studies of technology and organizing have generally sidestepped the role powerful actors play in shaping technologically occasioned organizational change [36]. In line with Leonard-Barton's [126] statement on '*implementation is innovation*', we focused on top managers as powerful actors who can obtain the great benefits of ERP investments, which we consider as emerging during the course of the TMT's encounters with the ERP system as they use it in the conduct of their everyday work through pragmatic action and situated improvisations. During the ERP journey, TMT members have shown different patterns of participation, thus differently contributing to ERP value creation. In contrast to the TMS literature, which is somewhat deterministic and uses a bottom-up approach to ERP implementation, we propose a change in the conversation by emphasizing the idea of a tighter and more continuous relationship between the TMT and the ERP system that extends beyond *support* to create ERP value. Consequently, we have intentionally paid attention to the content and effects of top managers' imbricated behavior, thus contributing to the specific body of knowledge about managerial agency on ERP value creation.

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Appendix

SCRIPT FOR INTERVIEWS

Questions related to investments in IT:

1. What kind of investments have you made? Why? How much did they cost?
2. In what functions or departments? At what level? In other words, at the management level for decision-making or at the operational level?
3. What kind of analysis was made of these investments? Is it documented? If so, could we see it?
4. Highlight the best and the worst of them.

Questions related to the relevant impacts of investments in IT:

5. Do you think that the IT you use can help you, or on the contrary, prevent you from achieving your goals? Why?
6. To achieve your objectives, do you consider it necessary to make any change in IT? And in the organization? If you remember other previous adjustments, why and how were they made?
7. What benefits have these investments had for your organization? This question will be triangulated with the impact section of the questionnaire.
8. If you have not had the expected benefits, why?

Questions related to the individual characteristics of managers:

9. What knowledge do you have on IT? This question will be triangulated with the competency of the questionnaire.
10. What experience do you have related to IT? This question will be triangulated with the competency of the questionnaire.
11. What is your vision of IT in this organization? That is, what role do you think they should play in this organization?
12. Do you have freedom of action to carry out your particular vision? That is, what is your degree of freedom with respect to investment, management and use of information technology? In case of a negative response, who should decide?

Questions related to the management processes:

13. Who participates in decisions related to information technologies? How do you make those decisions? If decision-making is not participatory, who usually makes those decisions?
14. Do you agree on how to make better use of information technologies? Why?

Questions related to the characteristics and organizational culture:

15. How does management support the use of new IT? Is there evidence? If so, could we see them?
16. Who leads the adoption and use of IT?
17. What level of competence in IT do people (staff) have here? Why?
18. Are your IT adjusted to your business strategy? Why?
19. Regarding other previous IT (which you no longer use), what inertias do you observe?

20. What relationship do you think exists between your organizational flexibility and the IT you use?
21. And with your communication habits?
22. And with your work environment?
23. And with your orientation to innovation?

Questions related to the environment:

24. Do you think that your direct competitors take more advantage of IT? Why?
25. From what you have done with IT, what actions have been motivated by the competitive pressure of your environment?
26. And, what actions have been motivated by government support, subsidies, etc.?
27. And, what actions have been motivated by the support of suppliers, external consultants, etc.?
28. And, what actions have been motivated by other business partners?

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An empirical analysis on the effects of investment assessment methods on IS/IT project success

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Abstract:

As organizations' investments on information systems/information technology (IS/IT) increase, the assessment methods used during IS/IT investment decision-making process holds more and more importance. Since successful IS/IT projects are key to the sustainability of an organization, identifying the factors which have effects on project success carries useful insights. In this study, 18 assessment methods are identified based on the literature. A novel classification method is proposed and assessment methods are classified into financial, strategic, and organizational categories. A novel rule-based method for determining the size of IS/IT projects is also proposed. Detailed information on project characteristics, employed IS/IT assessment methods, and project success is collected for 110 real-world IS/IT projects. The collected data is utilized in ANOVA and Regression tests to examine the factors which affect project success. Use of organization-related assessment methods, which is proposed in this study, is found to increase the success rate of the projects. Obligation towards the project and use of multi-criteria methodology have significant relationships with project success whereas project size, use of gut feeling during evaluation, and employed system development methodology do not have statistically significant impacts on project success.

Keywords:

IS/IT investments; assessment methodologies; project success; success criteria; project size.

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1. Introduction

Information systems/information technology (IS/IT) global spending is expected to reach the level of 2-3 trillion dollars by 2020, with sustained significant growth over the years [1]-[3]. IS/IT investments are also found to have a significant impact on economic growth and it is superior to other types of investments in terms of efficiency in growth output [4]. Moreover, a causal relationship exists between IT investments and productivity [5].

Various IS/IT investment assessment methods are available for evaluating projects prior to the final investment decision. Since investments are expected to provide benefits, financial or otherwise, to the company; the success of the invested projects carries uttermost importance. The purpose of this study is to explore IS/IT project characteristics and use of IS/IT investment assessment methods in actual IS/IT projects and finally determine their effects on the success of the projects. In achieving the stated purpose, an extensive survey is conducted on 110 IS/IT projects, descriptive statistics on those projects are analyzed, and Analysis of Variance (ANOVA) and Regression tests are carried out to examine factors affecting project success. The findings enable practitioners and researchers to gain insight into current practices in real-world IS/IT projects and provide prescriptions for conducting successful IS/IT projects.

The contribution of this paper includes, but is not limited to, the following:

- A novel categorization is developed for classifying IS/IT assessment methods;
- A real-world statistical data is provided on the characteristics and success rate of IS/IT projects;
- Use and importance of 18 IS/IT assessment methodologies are explored;
- The relationships between project success and employed assessment methods are examined.

This paper is structured as follows. In Section 2, the relevant literature which provides a background for the study is identified and briefly discussed. Subsequently, in Section 3, research aims are presented and hypotheses are developed. The methodology employed in this study is described in Section 4. Results and findings are presented in Section 5. Discussion on managerial implications, limitations of the study, and directions for future research are given in Section 6.

2. Background

This section provides a review of the literature on project characteristics, investment assessment methods, and project success with the purpose of providing a background on the effects of project characteristics and investment assessment methods on IS/IT project success.

Sauer et al. [6] study the impact of the project's size and volatility on its performance in terms of budget, schedule, and scope expectations. For classifying the projects based on size, they utilize budget, effort (average person months), duration, and team size. Aguilar et al. [7] survey 107 Mexican software development companies to investigate the size of projects built by these companies. They propose a rule-based method to classify projects as small, medium, and large-sized projects based on effort (work hours), duration, and full-time equivalent (FTE) staff of the project. However, project complicatedness measures such as problem and solution complexities, and interdependencies with other systems and projects are often overlooked while determining the size of the projects.

Joshi and Pant [8] classify IT projects in a discretionary-mandatory dimension. Purely discretionary projects indicate that the organization has complete flexibility in undertaking the project as well as in choosing the time frame for its execution. Purely mandatory projects, on the other hand, are the projects where the organization have no choice, but to undertake the project within a defined narrow time frame. Projects which fall between these two ends are either classified as mainly discretionary projects or mainly mandatory projects based on which end they are closer to. The relationship between project obligation and project success remains an open question for exploration.

In system development, agile and waterfall are considered as two competing approaches with more specific methodologies being the hybrid or derivations of the two. This view is almost universally accepted by both practitioners

and researchers. Accordingly, the current research in this field focuses on specific methodologies rather than challenging the widely-accepted two general approaches.

Ika [9] investigates the success criteria used in project management from the 1960s to the 21st century. As presented in Table 1, they suggested that in addition to the iron triangle which consists of time, cost, and quality; criteria such as user satisfaction and stakeholder satisfaction are also fundamental. Success measures for projects evolve over time and there is no universally accepted standard for all kinds of projects. Yet, a success measurement model which is generalizable for most projects and still relevant for individual projects is very useful.

Table 1. Project success criteria across time (adapted from Ika [9])

Research Focus	Period 1 1960s - 1980s	Period 2 1980s - 2000s	Period 3 21st Century
Success criteria	“Iron triangle” (time, cost, quality)	Iron triangle Client satisfaction Benefits to organization End-user’s satisfaction Benefits to stakeholders Benefits to project personnel	Iron triangle Strategic objective of client organizations and business success End-user’s satisfaction Benefits to stakeholders Benefits to project personnel and symbolic and rhetoric evaluation of success and failure

Bacon [10] examines the criteria used for allocation of IS/IT resources to candidate projects. Senior executives from 80 organizations are asked to specify the most popular 15 assessment criteria along with the respective frequencies. The study also groups criteria under financial, management, and development categories. Rosacker and Olson [11] investigate the IT project selection and evaluation methodologies through a survey of IT project management practitioners working in U.S. state governments. They also assess the relationships between selected assessment methods and success of the project and find that utilization of financial assessment methods is important in achieving project success in terms of budget. Khakasa and Ateya [12] conducted a similar study. Their study provides an empirical analysis on IT investment assessment methods used in banks in Kenya. The findings show that sophisticated techniques which integrate strategic and financial methods are less frequent than the use of traditional assessment methods which focus mostly on financial returns.

Renkema et al. [13] provide a reference framework for the assessment methodologies in the literature. They discern four basic categories: financial, multi-criteria, ratio, and the portfolio approach. The reviewed methods are then classified under those categories. Irani [14] reviews the literature on IS/IT investment assessment methods in manufacturing resource planning and provides a taxonomy of the methods. Moreover, the study proposes a conceptual model for IS/IT investment evaluation. Stix and Reiner [15] provide a critical review on IT appraisal methods and their categorizations. They place IS/IT investment assessment methods inside a triangle whose three corners represent the three categories: financial, multi-criteria, and strategic. Although some methods fall between multiple categories, all can be assigned to their predominant category. Ozturan et al. [16] examine over 50 academic articles and classified IS/IT investment assessment methods used in those studies into three categories as financial, non-financial, and hybrid. They find that although financial methods are more frequently used than non-financial methods, there is an increasing trend in the use of non-financial methods due to a tendency towards strategic and intangible benefits of IT.

Andresen [17] proposes a framework for selecting evaluation methods for IT projects in the construction industry, particularly in Denmark. Their survey of Danish companies shows that formal evaluation methods are only rarely used. Since there does not exist a single evaluation method which is best for all cases, their framework helps to find the best IT evaluation methods matching the needs of the company. In order to do such a match, the nature of the company, use of IT, business objectives, and reasons for evaluation are weighted and taken into account. Similarly, Chou et al. [18] propose a fuzzy multi-criteria decision model approach which considers compatibility and ability to integrate with

existing IT portfolio. Their two-stage evaluation process uses weights given to 26 IS/IT investment criteria to score candidate projects.

Table 2 presents IS/IT investment assessment methods employed in this study along with appropriate references and original categorizations by the respective authors in the literature. As depicted, studies in the literature do not agree on a widely-accepted classification but rather employ different categorizations. An exception to that is the traditional finance-related criteria which are labeled as financial in all reviewed literature except for Khakasa and Ateya [12] and Irani [14] where they are labeled as economic. For the other criteria, the majority of the literature makes the distinction based on whether the criterion is numeric/analytic or non-numeric, which in our opinion is insufficient since most methods contain both quantitative and qualitative components especially with the advance of data collection and analysis capabilities.

Table 2. Assessment methods for IS/IT investments

Assessment Method	Reference Category	References
Cost Benefit Analysis	Financial	[11], [12], [15]-[17]
	Economic	[12], [14]
Payback Period	Financial	[10], [11], [13], [17]
	Economic	[12], [14]
Return on Investment	Financial	[10], [15]-[17]
	Economic	[12], [14]
Net Present Value	Financial	[10], [11], [13], [16], [17]
	Economic	[12], [14]
Internal Rate of Return	Financial	[10], [11], [13], [17]
	Economic	[12], [14]
Technical Importance Assessment	Strategic	[12], [14]
	Development	[10]
Competitive Advantage Analysis	Qualitative	[11], [12]
	Strategic	[14]
	Management	[10]
IT Portfolio Analysis	Non-financial	[16]
	Strategic	[12]
	Portfolio	[13]
	Multi-criteria	[15]
	Qualitative	[17]
SWOT Analysis	Strategic	[15]
Risk Analysis	Non-financial	[16]
	Analytic	[12], [14]
Value Analysis	Non-financial	[16],
	Analytic	[12], [14]
Opinions of Experts	Financial	[17] (as <i>Delphi Evidence</i>)
Human Resource Availability	-	[18]
Administrative Necessities	Management	[10]
Legal Necessities	Qualitative	[11]
	Management	[10]
Suitability for Development	Development	[10]
Operability after Deployment	Development	[10]
Gut Feeling	Qualitative	[11]
	Gut Feeling	[12]

3. Research aims and hypothesis building

This study has two main research aims. The first is to explore the characteristics, success, and employed assessment methods for IS/IT projects conducted in the industry. The second is to examine the effects of project characteristics and employed IS/IT investment assessment methods on project success.

Project characteristics, investment assessment methods, and project success. Understanding the problem setting and current practices is a prerequisite for most problems, particularly in IS/IT management field. Such information can yield useful practical insights and enables formulation of further sophisticated research questions. Accordingly, first research aim requires analysis of the project characteristics in terms of project size, the obligation towards the project, and employed system development methodology as well as the project success and the use of investment assessment methods. To the best of our knowledge, this is the first study which investigates mentioned characteristics simultaneously. Further to that, project size is measured by a novel, more comprehensive classification method which considers problem and solution complexities, and interdependencies in addition to the traditional metrics of budget, duration, and FTE staff. In accordance with the earlier discussion in the previous section, project success is also measured via a more contemporary approach rather than the traditional metrics of time, cost, and quality. For potentially hundreds of investment assessment methods, most frequently used methods are identified and presented with a novel categorization based on an analysis of the literature. A detailed discussion on the operationalization of the variables is given in the next section.

The second research aim investigates the factors affecting project success. Objectives under this aim are stated as formal hypotheses, which can be tested by conducting appropriate statistical tests. This research aim can further be divided into two subcategories based on whether the effects of project characteristics on project success are investigated or the effects of investment assessment methods on project success are investigated.

Effect of project characteristics on project success. As discussed earlier and as evident from the literature, the relationship between employed system development methodology and project success is a field of its own. Yet, an empirical comparison of agile and waterfall methodologies in terms of eventual project success is valuable for providing further evidence or counter-evidence for the literature. On the other hand, the relationship between project size and project success have only been explored using less sophisticated measurement models, and the relationship between obligation towards project and project success is not investigated at all. Therefore, investigating how projects with varying characteristics are likely to be successful is an obvious research direction. It carries not only scientific importance but very strong and immediate practical importance as well. To the best of our knowledge, this the first study which employs all of the listed project characteristics and examines their effects on project success. The formal hypotheses regarding the relationship between project characteristics and project success are given below.

- **H1.** There is a relationship between project size and project success.
- **H2.** There is a relationship between obligation towards project and project success.
- **H3.** There is a relationship between employed system development methodology and project success.

Effect of assessment methods on project success. As discussed earlier in this work, the existing studies on IS/IT investment assessment methods are very limited in number and scope, and mostly take interest in how to classify different assessment methods and how frequently those methods are used in actual IS/IT projects. As a result, a sufficient analysis of the relationship between the use of assessment methods and project success is lacking even though the ultimate goal of IS/IT investment assessments is choosing the projects with highest returns. Obviously, the success rate of projects would increase the return from investments. If project executives have the knowledge on which assessment methods would yield more accurate predictions on project success, then the success rate of projects can be improved through better assessment. Moreover, our study employs a novel classification of assessment methods since no agreed upon sufficient classification method exists in the literature, as discussed earlier in the previous section and will be detailed in the next section. On the other hand, the fact remains that the use of multi-criteria method might have an effect on project success since utilizing different types of assessment methods adds new perspectives and provides triangulation in assessing the investments. On that account, the existence and size of the effect of employing the multi-

criteria method is also an interesting problem for the IS/IT management community. The formal hypotheses regarding the relationship between IS/IT investment assessment methods and project success are given below.

- **H4.** There is a relationship between categories of employed IS/IT investment assessment methods and project success.
 - H4a.* There is a relationship between use of financial assessment methods and project success.
 - H4b.* There is a relationship between use of strategic assessment methods and project success.
 - H4c.* There is a relationship between use of organizational assessment methods and project success.
 - H4d.* There is a relationship between gut feeling and project success.
- **H5.** There is a relationship between multi-criteria method use and project success.

4. Methodology

This section begins with a description of the methodology used in the measurement and operationalization of variables employed in this study under project characteristics, assessment methodologies, and project success categories. The section concludes with the details of the data collection process.

4.1 Project characteristics

The methodology employed in determining project characteristics such as sector, project size, obligation towards project, and employed system development methodology is explained in this section.

Sector. List of sectors is taken from the list of supersectors in FTSE Russell Industry Classification Benchmark (ICB) [19]. ICB is a distinguished standard categorizing companies to subsectors which most closely represents the nature of their business, which is determined by its primary source of revenue and other publicly available information. In addition to those sectors, our study provides the *Other* option and allows respondents to specify the sector of their project. Among the responses which specified their sector as *Other*, the most popular sector was *Education*. List of sectors is presented in Table 3.

Table 3. List of sectors

Automobiles & Parts	Construction & Materials	Food, Beverage & Tobacco	Media	Technology
Banks	Consumer Products & Services	Healthcare	Personal Care, Drug & Grocery Stores	Telecommunications
Basic Resources	Energy	Industrial Goods & Services	Real Estate	Travel & Leisure
Chemicals	Financial Services	Insurance	Retail	Utilities

Project Size. Following the similar methods employed by Sauer et al. [6], Aguilar et al. [7], and several organizations such as universities and state departments [20]-[22] the following methodology is used to classify projects as small, medium, or large. Three levels are determined for each of full-time equivalent (FTE) staff, duration, number of departments involved, number of links to other systems and projects (interdependency), problem complexity, and solution complexity. Each project is then classified under one of the three levels for each criterion. Assuming that the third level signals larger projects whereas the first level signals smaller projects, each project is assigned a point based on its classifications under all criteria. The first level contributes zero points whereas the second and third level contributes 1 and 2 points respectively. Projects which have up to 4 points are categorized as small. Projects which have at least 10 points are categorized as large. The rest are classified as medium-sized projects. Table 4 summarizes the novel classification methodology employed in this study.

Table 4. IS/IT project size classification methodology

	0 pts.	1 pts.	2 pts.
Budget	Less than £50,000	£50,000 - £250,000	More than £250,000
FTE staff	Less than 5 people	5 - 9 people	More than 10 people
Duration	Less than 4 months to reach operational status	4 - 12 months to reach operational status	More than 12 months to reach operational status
Departments Involved	1 - 2 departments	3 - 4 departments	More than 4 departments
Interdependency	No links or only a few links to other systems and projects	Several links to the other systems and projects	Many links to the other systems and projects
Problem Complexity	The problem is easy to understand and define.	The problem has medium difficulty for understanding and defining.	Problem is difficult to understand and define.
Solution Complexity	The solution is easily achievable.	The solution is achievable but not as easily.	The solution is unclear and difficult to achieve.
	Small	Medium	Large
Points	0 - 4 pts.	5 - 9 pts.	10 - 14 pts.

Obligation. The organization’s obligation towards each IS/IT investment can be different and these differences might affect the project success. Therefore, all projects are classified as purely discretionary, mainly discretionary, mainly mandatory, or purely mandatory based on the work of Joshi and Pant [8].

System Development Methodology. Projects are categorized based on whether their employed system development methodology fits under *agile* or *waterfall* approaches. Waterfall approach is a sequential process where each phase is completed before moving to the next phase. Agile approach, on the other hand, is an incremental process where work is divided into multiple deliveries and an iterative methodology is employed. For projects where such distinction is not applicable or the system development methodology is unknown, a third option named *unclear/unknown* is also provided.

4.2 Investment assessment methodologies

After reviewing the literature for classifications of IS/IT investment assessment methodologies in Section 2, a novel set of categories is employed which classify the given assessment methods under financial, strategic, and organizational categories as shown in Table 5.

In the literature, there is a widely-accepted consensus regarding which methods belong to the financial category. For the nonfinancial methods, a sizable portion of the previous literature makes the distinction based on whether they are numeric or non-numeric (quantitative or qualitative, analytic or not). However, most methods often contain both numeric and non-numeric parts which make such classification less accurate. To overcome this problem, this study approaches the issue by introducing an organizational perspective and making the distinction between strategy- and organization-related methods. In this way, it becomes easier to classify assessment methods which contain both numeric and non-numeric information.

In addition to the data collected on the level of importance given to each assessment method during the IS/IT investment decision, a separate data is also collected on whether a multi-criteria evaluation method (e.g., scoring method) is employed or not.

Table 5. Classification of assessment methods for IS/IT investments

Financial	Strategic	Organizational	Gut feeling
Cost Benefit Analysis	Technical Importance Assessment	Human Resource Availability	Gut feeling
Payback Period	Competitive Advantage Analysis	Administrative Necessities	
Return on Investment	IT Portfolio Analysis	Legal Necessities	
Net Present Value	SWOT Analysis	Suitability for Development	
Internal Rate of Return	Risk Analysis	Operability after Deployment	
	Value Analysis		
	Opinions of Experts		

4.3 Project success

Adapting from Ika [9], this study measures success in five dimensions: whether the project is completed (i) within time, (ii) within budget; whether the project output meets (iii) technical requirements, (iv) functional requirements; and (iv) how the stakeholders rate the success of the project.

First four criteria correspond to the iron triangle where quality is measured in two dimensions as technical and functional. End-user satisfaction is not included as a separate dimension since the people who respond to the questionnaire might not accurately know the level of satisfaction that end-users have. The last dimension, stakeholder satisfaction, is expected to reflect end-user satisfaction up to a certain degree.

4.4 Data collection

An online questionnaire was prepared with the purpose of collecting information regarding the use of assessment methods for IS/IT projects in the real world along with sector of the project, project characteristics, and success metrics as explained previously in Section 4. The complete questionnaire can be found in Appendix A. The questionnaire was sent out to executives, managers, and project management professionals majority of whom works in Turkey. They were also encouraged to forward the questionnaire to other people who might have the information to respond to the questionnaire.

The data was collected over the first half of the year 2018. Total of 110 responses are obtained. Upon investigation, all responses are deemed as valid and no response is filtered out, resulting in a final sample size of 110. However, not all of the responses are for completed projects since information is collected also on projects which are not completed. The statistics are presented in the next section.

5. Results and findings

5.1 Project characteristics, investment assessment methods, and project success

In the real world, it is expected that the sectors like technology and banks to have a greater number of IS/IT projects and the sectors like chemicals and utilities to have a relatively lower number of IS/IT projects given the size of the sectors and relative importance of IS/IT in each sector. Table 6 shows the distribution of the projects by sectors in our sample. In line with our initial expectation, most of the projects (20%) are from the technology sector followed by the banks sector (%15). The sectors where IS/IT is not as crucial as other sectors and the smaller sectors have a lower number of projects. Therefore, we can conclude that our sample adequately reflects the population.

Table 6. Distribution of projects by sectors

Sectors	Complete	Incomplete	Total	
	N (70)	N (40)	N (110)	%
Technology	12	10	22	20%
Banks	12	4	16	15%
Retail	4	6	10	9%
Others	7	3	10	9%
Financial Services	3	4	7	6%
Automobiles & Parts	5	1	6	5%
Telecommunications	4	1	5	4%
Health Care	4	1	5	4%
Insurance	5	0	5	4%
Industrial Goods & Services	2	2	4	4%
Media	3	1	4	4%
Energy	1	2	3	3%
Utilities	3	0	3	3%
Construction & Materials	1	1	2	2%
Travel & Leisure	1	1	2	2%
Consumer Products & Services	1	1	2	2%
Food, Beverage & Tobacco	0	2	2	2%
Chemicals	1	0	1	1%
Personal Care, Drug & Grocery Stores	1	0	1	1%

Table 7 shows the number of complete and incomplete projects in terms of size, obligation, and system development methodology. According to the results, medium-sized projects constitute 42% of all projects. In terms of completion rate, small-sized projects have the highest rate with 77% which indicates that dividing larger scopes into smaller projects might increase the chance of completion. In terms of obligation, the projects which are at the two ends of the scale have a larger rate of completion. It is intuitive that purely mandatory projects to have higher completion since the organizations have no chance but to complete them. However, it is interesting that purely discretionary projects have a similar completion rate as well. The projects which are part mandatory and part discretionary have lower completion rates but constitute two-thirds of all projects. In system development, agile methods are used more frequently than the waterfall methods, reflecting the current trend towards the agile. Completion percentage of agile and waterfall methods are close to each other but projects which have no clear methodology (i.e., uncertain/unknown) have lower completion rates which hint the importance of employing a well-defined system development methodology.

Table 8 shows the number of complete and incomplete projects in terms of sub-items of the size criteria. According to results, while projects having more than 250.000 Turkish Liras budget is the highest percentage of all projects with 55%, projects having less than 50.000 Turkish Liras budget has the highest completion percentage with 79%. Projects lasting 4 – 12 months have the highest number of projects and completion percentage when comparing duration levels. Whereas the number of projects with less than five people is the highest among full-time equivalent staff levels with 38%, projects with more than 10 people have the highest completion percentage with 69%. When the number of involved departments increases, completion percentage decreases which signals possible communication and co-working issues prohibiting completion of such projects. In both problem and solution complexity, projects with medium

complexity constitute the largest level among complexity levels. Counterintuitively, the projects which have more complex problems do not have lower completion rates. Yet, the projects which have very complex solutions have a lower rate of completion, and therefore the solution complexity seems to be a more decisive issue rather than the hardness of the problem.

Table 9 shows descriptive statistics for investment assessment methods for the IS/IT projects. Organizational assessment methods have the highest mean scores among four assessment method categories whereas gut feeling is the lowest one, which contradicts the belief that gut feeling plays a significant role in project selection. Financial methods on average have the lowest score which challenges the traditional view that economic feasibility is the prominent determining criterion in project selection. Financial and organizational assessment methods consist of five items (respectively, Cronbach's $\alpha = .830$, Cronbach's $\alpha = .732$) whereas strategic assessment methods consist of seven items (Cronbach's $\alpha = .834$). Since Cronbach's α values are greater than 0.7 for all categories, internal consistencies within the categories are satisfied.

Furthermore, survey results show that 53% of projects use the multi-criteria method but the remaining 47% do not. Among projects which employ multi-criteria method, the completion rate is 62%. On the other hand, the completion rate for projects where the multi-criteria method is not used is 65%. Hence, there seems to be no substantial difference in project completion rate based on whether the multi-criteria method is used or not.

Table 10 shows descriptive statistics for IS/IT project success. Meeting stakeholders' requirements has the highest mean among five sub-success criteria which might indicate that projects are driven to satisfy stakeholders' requirements. Time goals have the lowest score which strengthens the common observation that projects often overrun their deadlines.

Table 7. Distribution of IS/IT projects by their characteristics

	Complete	Incomplete	Completion Rate	Total	
	N (70)	N (40)	%	N (110)	%
Size					
Small	20	6	77%	26	24%
Medium	27	19	59%	46	42%
Large	23	15	61%	38	34%
Obligation					
Purely Discretionary	9	3	75%	12	11%
Mainly Discretionary	16	10	62%	26	23%
Mainly Mandatory	27	20	57%	47	43%
Purely Mandatory	18	7	72%	25	23%
System Development Methodology					
Waterfall	24	13	65%	37	34%
Agile	35	18	66%	53	48%
Uncertain/Unknown	11	9	55%	20	18%

Table 8. Descriptive statistics for sub-items of the size of IS/IT projects

	Complete	Incomplete	Completion Rate	Total	
	N (70)	N (40)	%	N (110)	%
Budget (in Turkish Liras*)					
Less than 50.000	15	4	79%	19	17%
50.000 - 250.000	18	13	58%	31	28%
More than 250.000	37	23	62%	60	55%
Duration					
Less than 4 months	19	9	68%	28	25%
4 - 12 months	34	15	69%	49	45%
More than 12 months	17	16	52%	33	30%
Full-time Equivalent Staff					
Less than 5 people	27	15	64%	42	38%
5 - 9 people	16	13	55%	29	26%
More than 10 people	27	12	69%	39	36%
Number of Departments					
1 - 2 departments	27	14	66%	41	37%
3 - 4 departments	26	13	67%	39	36%
More than 4 departments	17	13	57%	30	27%
Number of Links					
No links	15	1	94%	16	15%
Several Links	18	13	58%	31	28%
Many Links	37	26	59%	63	57%
Problem Complexity					
Easy	22	12	65%	34	31%
Medium	33	21	61%	54	49%
Hard	15	7	68%	22	20%
Solution Complexity					
Easy	15	10	60%	25	23%
Medium	36	15	71%	51	46%
Hard	19	15	56%	34	31%

* 1 US Dollars \approx 4 Turkish Liras at the time of data collection

Table 9. Descriptive statistics for the investment assessment methods for the IS/IT projects

	Complete		Incomplete		Total	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Financial Methods (Cronbach's $\alpha = .830$)	3.07	1.06	3.27	0.77	3.14	0.97
Cost Benefit Analysis	3.53	1.20	3.85	0.98	3.65	1.13
Payback Period	2.79	1.39	3.00	1.18	2.86	1.32
Return on Investment	2.96	1.36	3.38	1.15	3.11	1.29
Net Present Value	2.89	1.27	3.00	1.09	2.93	1.20
Internal Rate of Return	3.19	1.38	3.13	1.20	3.16	1.31
Strategic Methods (Cronbach's $\alpha = .834$)	3.19	0.95	3.41	0.81	3.27	0.91
Technical Importance Assessment	3.33	1.20	3.73	1.01	3.47	1.15
Competitive Advantage Analysis	3.13	1.37	3.63	1.43	3.31	1.41
IT Portfolio Analysis	3.19	1.35	3.20	1.36	3.19	1.35
SWOT Analysis	2.91	1.25	3.05	1.32	2.96	1.27
Risk Analysis	3.04	1.35	3.30	1.29	3.14	1.32
Value Analysis	3.07	1.32	3.40	1.32	3.19	1.32
Opinions of Experts	3.64	1.09	3.58	1.15	3.62	1.11
Organizational Methods (Cronbach's $\alpha = .732$)	3.51	0.94	3.39	0.67	3.46	0.85
Human Resource Availability	2.99	1.20	2.83	1.22	2.93	1.20
Administrative Necessities	3.51	1.25	2.98	1.25	3.32	1.27
Legal Necessities	3.47	1.49	3.75	1.21	3.57	1.40
Suitability for Development	3.67	1.14	3.90	0.90	3.75	1.06
Operability after Deployment	3.90	1.18	3.48	1.04	3.75	1.14
Gut Feeling	2.42	1.16	2.87	1.28	2.59	1.22

Table 10. Descriptive statistics for success of the IS/IT projects

	N	Min.	Max.	Mean	Std. Deviation
Meeting Project Budget Goals	70	1	5	3.73	0.93
Meeting Project Time Goals	70	1	5	3.54	0.91
Meeting Technical Requirements	70	1	5	3.89	0.89
Meeting Functional Requirements	70	1	5	3.79	0.87
Meeting Stakeholders Requirements	70	1	5	4.01	0.94
Average Success	70	1	5	3.79	0.75

5.2 Examining the effects on project success

The proposed hypotheses are tested and interpreted for the 70 completed IS/IT projects.

Hypothesis 1: There is a relationship between project size and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 1. The one-way ANOVA test ($F(2, 67) = 0.468$, $p = .629$) revealed that there is not a statistically significant difference between the size of the projects in terms of success. Table 11 presents mean success, standard deviation, and number of projects for each project size.

Table 11. Project success by size

Size	Mean	St. Dev.	N (70)
Small	3.66	1.05	20
Medium	3.87	0.64	27
Large	3.81	0.56	23

p-value = .629

Hypothesis 2: There is a relationship between obligation towards project and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 2. The one-way ANOVA test ($F(3, 66) = 5.018$, $p = .003$) revealed that there is a statistically significant difference between obligation of the projects in terms of success. A Tukey post hoc test revealed that purely discretionary projects ($M = 2.96$, $SD = 1.17$) have significantly lower mean success scores than mainly discretionary projects ($M = 3.95$, $SD = 0.68$), mainly mandatory projects ($M = 3.90$, $SD = 0.52$), and purely mandatory projects ($M = 3.90$, $SD = 0.63$). Table 12 presents mean success, standard deviation and number of projects for each level of obligation.

Table 12. Project success by obligation

Obligation	Mean	St. Dev.	N (70)
Purely Discretionary	2.96	1.17	9
Mainly Discretionary	3.95	0.68	16
Mainly Mandatory	3.90	0.52	27
Purely Mandatory	3.90	0.63	18

p-value = .003

Hypothesis 3: There is a relationship between employed system development methodology and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 3. The one-way ANOVA test ($F(2, 67) = 1.292$, $p = .282$) revealed that there is not a statistically significant difference between system development methodology of the projects in terms of success. Table 13 presents mean success, standard deviation, and number of projects for each system development methodology.

Table 13. Project success by system development methodology

System Development Methodology	Mean	St. Dev.	N (70)
Waterfall	3.82	0.65	11
Agile	3.98	0.57	24
Uncertain/Unknown	3.66	0.87	35

p-value = .28

Hypothesis 4: There is a relationship between categories of employed IS/IT investment assessment methods and project success.

Simple regressions are performed to explain the relationship between success of projects and assessment method categories used in project evaluations: financial, strategic, organizational, and gut feeling. Table 14 provides the results for the four sub-hypotheses of Hypothesis 4 and each sub-hypothesis is examined in this section according to the results given in the table.

Table 14. Regression results for the relations between investment assessment method categories and project success

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R ²	
	B	Std. Error	Beta				
H4a	(Constant)	3.151	.266		11.852	.000	.087
	Financial Methods	.209	.082	.295	2.548	.013	
H4b	(Constant)	3.042	.304		10.019	.000	.089
	Strategic Methods	.235	.091	.298	2.576	.012	
H4c	(Constant)	2.450	.311		7.887	.000	.227
	Organizational Methods	.382	.086	.476	4.468	.000	
H4d	(Constant)	3.606	.218		16.509	.000	.013
	Gut Feeling	.076	.081	.112	.930	.355	

Hypothesis 4a. This hypothesis is accepted ($p < 0.05$) and use of the financial assessment methods explain 8.7% of the variability in success.

Hypothesis 4b. This hypothesis is accepted ($p < 0.05$) and use of the strategic assessment methods explain 8.9% of the variability in success.

Hypothesis 4c. This hypothesis is accepted ($p < 0.001$) and use of the organizational assessment methods explain 22.7% of the variability in success.

Hypothesis 4d. This hypothesis is rejected ($p = 0.355$) and therefore use of gut feeling does not have a statistically significant effect on project success.

All three categories of assessment methods are found to have relations with project success. However, the variance explained by financial and strategic assessment methods are relatively low and each can only explain less than 10% of the variance in success separately. In contrast, use of organizational assessment methods alone can explain more than 20% of the variance in success. The direction of the relationship is positive for all assessment method categories. Use of gut feeling does not impact the project success either in a negative or in a positive way.

Hypothesis 5: There is a relationship between multi-criteria method use and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 5. The one-way ANOVA test ($F(1, 68) = 6.460$, $p = .013$) revealed that there is a statistically significant difference between the projects where multi-criteria method is used and those which it is not used in terms of success. A Tukey post hoc test revealed that projects which have not used multi-criteria ($M = 4.02$, $SD = 0.64$) have significantly higher mean success scores than those which employ multi-criteria method ($M = 3.58$, $SD = 0.80$). Table 15 presents mean success, standard deviation, and number of projects for multi-criteria method.

Table 15. Project success by multi-criteria method

Multi-criteria Method	Mean	St. Dev.	N (70)
Not used	4.02	0.64	34
Used	3.58	0.80	36

p-value = .013

6. Conclusion

This study provides background on classifying IS/IT projects by their size and proposes a rule-based method for determining the size of a given IS/IT project as small, medium, or large. Existing approaches to measuring IS/IT project success are compared and a generalizable and relevant measurement model is presented. Moreover, categorizations for IS/IT investment assessment methods in the literature is analyzed and a new, more accurate categorization which consists of financial, strategic, and organizational categories is proposed. Statistical tests are then performed to analyze the extensive data collected for 110 IS/IT projects from different sectors with respect to the project characteristics, use of assessment methods, and their relationships with project success.

The findings indicate that employing more and variety of IS/IT investment assessment methods have a positive impact on the success of a project. Assessment methods falling under the proposed organizational category are shown to have a greater relationship with project success when compared with other method categories. Therefore, organizations should not rely only on traditional financial and strategic assessment methods but also consider organizational criteria in the pre-investment evaluation of IS/IT projects. Contrary to some findings in the literature [23], gut feeling is found as the least preferred method among all. Furthermore, it does not positively or negatively affect project success. Moreover, counter-intuitively, employing a multi-criteria method is found to have a negative impact on project success.

Project success is higher for mandatory projects. Although the reasons behind this must be explored in detail, presenting a project as mandatory within the organization might increase the chance of success. Other results show that small projects have the highest completion rate. Especially, the projects which have no links to other systems have a completion rate of 94%. However, it should be noted that incomplete projects do not necessarily mean canceled or

unsuccessful projects but might also be ongoing projects which will eventually be completed successfully. Yet, these results still carry useful insights for researchers and practitioners.

On the other hand, there exist certain limitations for the study. First, the size of the sample used in this study is 110. Information on project success is only available for 70 of them since only that number of the projects are completed. Findings can be more generalizable if hypotheses are tested with a larger sample size. Second, only 18 investment assessment methods are considered in the study. Even though the assessment methods are selected based on popularity in the literature and also professional views of the authors, other assessment methods can be added as well. Lastly, the data is collected via a self-reported questionnaire thus it is possible that respondents may give inaccurate/incomplete information.

Future research studies can test the extent of generalizability of our findings by collecting and analyzing survey data from various regions of the world, possibly with different cultures and levels of development. Moreover, less structured, rich, and useful information can be uncovered via conducting in-depth interviews, focus groups, and analyzing existing documents. A qualitative approach utilizing such data sources can be designed to provide methodological triangulation to further validate our findings. Additionally, an action research study can be conducted by implementing changes guided by the findings, and then collecting and analyzing evidence so that the findings are also validated in the real world.

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Appendix A. Questionnaire

Items for the questionnaire used in this study are listed below.

1. Which sector does your company fit the best?
 - List of supersectors from FTSE Russell [19]
2. If *Other*, please specify the sector of your company.
 - Free text input
3. What is the planned budget of the project?
 - Less than 50.000 TL
 - Between 50.000 TL and 250.000 TL
 - More than 250.000 TL
4. How many people work in the project, in terms of full-time equivalent staff?
 - Less than 5 people
 - Between 5 - 9 people
 - More than 10 people
5. What is the planned duration for the project?
 - Less than 4 months to reach operational status
 - 4 - 12 months to reach operational status
 - More than 12 months to reach operational status
6. How many departments are involved with the development of the project?
 - 1 - 2 departments
 - 3 - 4 departments
 - 5 or more departments
7. Which of the following statements best describes the proposed information system?
 - It has no link or only a few links to other systems and projects.
 - It has several links to the other systems and projects.
 - It has many links to the other systems and projects.
8. Which of the following statements best describes the problem that the project aims to solve?
 - The problem is easy to understand and define.
 - The problem has medium difficulty for understanding and defining.
 - Problem is difficult to understand and define.
9. Which of the following statements best describes the solution that the project aims to bring?
 - The solution is easily achievable.
 - The solution is achievable but not as easily.
 - The solution is unclear and difficult to achieve.
10. What type of system development methodology is employed in the project?
 - Agile
 - Waterfall
 - Unclear/Unknown
11. Which of the following statements best describes the organization's obligation towards the project?
 - Purely Discretionary: The organization have complete flexibility in undertaking the project as well as in choosing the time frame for its execution
 - Mainly Discretionary
 - Mainly Mandatory
 - Purely Mandatory: The organizations have no choice, but to undertake the project within a defined narrow time frame.
12. Please specify the degree of consideration for each of the following in decision-making process of the project investment. (5-point Likert scale: Not at all, Low, Moderate, High, Very high)

- Cost Benefit Analysis
 - Payback Period
 - Return on Investment
 - Net Present Value
 - Internal Rate of Return
 - Technical Importance Assessment
 - Competitive Advantage Analysis
 - IT Portfolio Analysis
 - SWOT Analysis
 - Risk Analysis
 - Value Analysis
 - Human Resource Availability
 - Administrative Necessities
 - Legal Necessities
 - Suitability for Development
 - Operability after Deployment
 - Opinions of Experts
 - Gut Feeling
13. Have you applied an overall multi-criteria evaluation method (e.g., scoring models) using the investment assessment methods you considered?
- Yes
 - No
14. Is the project completed?
- Yes
 - No
- The following questions are asked only if the project is completed. They use five-point likert scale: Very Poor, Poor, Acceptable, Good, Very Good
15. How did the project do in meeting project budget goals?
16. How did the project do in meeting project time goals?
17. How did the project do in meeting technical requirements?
18. How did the project do in meeting functional requirements?
19. How did the stakeholders of the project rate the success of the project?

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Towards design of citizen centric e-government projects in developing country context: the design-reality gap in Uganda

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Towards design of citizen centric e-government projects in developing country context: the design-reality gap in Uganda

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Abstract:

E-government projects should be at the heart of service delivery in developing countries if the lives of citizens, especially the socially and economically marginalized, are to be improved. However, quite often in developing country contexts, citizens have been treated as recipients of technology projects through a top-down approach from central governments. Such a paradigm of implementation usually results in the non-use of the deployed technologies and their associated e-services. A consequence of non-use of e-services results in a wastage of the public fiscus. The extant literature points to a number of underlying causes of the problem. One such problem which has been highlighted is called the "Design-Reality gap". This paper investigates the nature of the gap. It presents findings from policy analysis and in-depth face-to-face interviews with e-government policy makers and implementers. In addition, it reports on findings from focus group discussions with potential e-government users in a health sector setting. The results which are based on a participatory action research methodology reveal that there exists a glaring design-reality gap between e-government policy planners and citizens' aspirations. We argue that co-creation could be a feasible approach for the design of e-government application services towards efforts to bridge the design-reality gap.

Keywords:

project participatory design; e-government; design-reality gap; co-creation; marginalized citizens.

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1. Introduction

Governments worldwide have devised and encouraged the application of Information and Communication Technology (ICT) in governance. As a consequence of such a commitment, a number of electronic government (e-government) applications have been deployed in both developed and developing countries. For instance, in the Ugandan context, which serves as the selected case of this paper, these systems include: Integrated Financial Management System (IFMS) for budgeting and control of expenditures, Integrated Personnel and Payroll System, Education Management Information System, Health Management Information Systems and the land information system among others. Such application deployments in Uganda are consistent with Gonzalez-Zapata and Heeks [1] who estimated that US\$3 trillion was spent on information technology by governments between 2000-2010, with an overall failure rate of 60%. However, despite the increasing penetration of the Internet in developing countries, the available literature including a United Nations Reports reveals that the African region overall lags in electronic government (e-government) development compared to the rest of the world [1].

The Chaos Reports [2-4], which categorize projects globally by how they are concluded, highlights the following resolutions:

- Resolution Type 1 (project success): The project is completed on-time and on-budget, with all features and functions as initially specified;
- Resolution Type 2 (project challenged): The project is completed and operational but over-budget, over the time estimate, and offers fewer features and functions than originally specified;
- Resolution Type 3 (project impaired): The project is cancelled at some point during the development cycle.

The 2018 CHAOS Report [4], which measures projects against the CHAOS database using six metrics of being on time, on budget, on target, on goal, valuable, and customer satisfaction, revealed that 52% of projects are challenged, 30% successful, and that 19% failed. User involvement features in the top 20% of the metrics for projects that are successful. The CHAOS research clearly shows that projects that lack user involvement perform poorly. This therefore indicates that user involvement and hence usability related issues are a key success metric. Instances of user involvement during the project cycle include participation in the information gathering process, application requirements review, basic research, prototyping and other consensus building tools.

One of the underlying causes of the failure of ICT projects has been termed as “*a design-reality gap*” [5]. A contributing factor to project failure is an assumption that existing system design frameworks inherent in e-government frameworks, can act as, for example, “*a one size fits all*” solution [6]. Such a design-reality gap is exacerbated by the design of e-government projects in a top-down approach from central governments. This situation has not yielded positive results especially considering marginalized citizens who have competing needs. Additionally, some e-government projects have been deployed using linear models and imminent failure is evident. For instance, Table 1 provides a comparison of agile and waterfall methods, where the former has some form of iterative design (or participatory design).

Table 1: A comparison of project failure rate between Agile and Waterfall project approaches

Project Size	Agile	Waterfall
Small	4%	11%
Medium	11%	25%
Large	23%	42%
All sizes	9%	29%

Source: Standish Group [3]

The data from table 1 reveals that agile projects which have an inherent iterative or participatory design component have a lower failure rate. Taking failure into account, this paper reports on a study that was undertaken in a selected district in the Ugandan context, within a health setting to serve as the unit of analysis. The research study investigated an alternative approach to incept, design and deploy e-Government applications and projects together with the intended users of such systems. This paper draws from participatory action research methods while harnessing the design science research paradigm and design thinking principles.

The primary question that this paper addresses is, “*How do e-government policy designers and implementers undergo early requirements gathering to align their project design intentions to citizens’ aspirations and needs in a marginalized context?*” In pursuance of the latter, the specific sub-questions which underpinned the research were:

- What are the citizen-focused e-government interventions under the strategic direction of the Ugandan Ministry of ICT that are aimed at service delivery improvement?
- What are the citizens’ needs and to what extent are their aspirations aligned to the National e-government strategy roadmap?
- Are there conceptual divergences between citizens’ requirements and governments’ requirements which impact on e-government strategy and its associated project design and programming?
- How can such divergences be mitigated in order to bridge the design-reality gap and thereby develop citizen centric e-government projects?

The remainder of the paper is structured as follows. Firstly a literature review is presented, which underscores the socio-technical underpinning of ICT development and the lack of citizen-centricity in respect of e-government applications. This is followed by the presentation of the research design in which an Iterative Co-Design Research Model is presented, as well as the details of the case study design and the qualitative data analysis process that were applied in the study. Finally the results of the study are discussed after which the conclusions are presented in which the key findings are synthesised into a Government to Citizen (G2C) Design-Reality Gap Theory of Change.

2. Literature Review

2.1 The notion of marginality

Marginality has been conceptualized as an adverse state or condition of existence of individuals or groups in a relation of subordination or inferiority to individuals or groups that are at the ‘centre’ or ‘mainstream’ [7]. In the event that there is no marginality, there can be centrality. Marginalization has been conceptualized as the process by which the condition of marginalized is reached [7]. Whereas marginality has been rooted in cultural and structural contexts, new forms have been linked to social exclusion and also, in relation to this study, to digital exclusion or digital divide especially in developing nations [8-9]. From the United Nations Development Programme (UNDP) human development report entitled, ‘*human development for everyone*’ [10], one in three people in developing nations continue to live in low levels of human development. The report shows that in most developing countries several groups face disadvantages that often overlap and reinforce each other which include, increasing vulnerability, widening the progress gap across generations, and making it harder for such nations and their citizens to catch up as the world moves on [10].

In developing nations, quite a number of populations have been stratified under marginality and they include: women, people with disabilities, youth and minority groups among others [11-12]. However, in terms of development, the most affected are those who are marginalized yet they are dynamic promoters of social and economic transformations in society and active agents [13]. They may include youth, rural community leaders and self-help groups, women, small and medium enterprises in rural and urban peripherals [14]. ICT and the Internet have the capability to improve the state of marginality in the form of information access from the pursuit of efficiency to effectiveness of public service delivery [15]. The cooperation between a government and its citizens is not only an issue of electronic interfaces (e-government), but most importantly a question of high quality and reliable services in a bid to improve the human

development capabilities [16-17]. There are various conceptualizations of e-government for improving citizen services [18].

2.2 ICTs projects for marginalized citizens

Information and Communications technologies (ICTs) have the ability to empower the poor marginalized communities [11]. Lofstedt [18] examines e-government from a more diverse perspective. They are management and organization, Electronic Democracy (e-democracy), interactions, Electronic Security (e-security) and Electronic Services (e-services) (Figure 1).

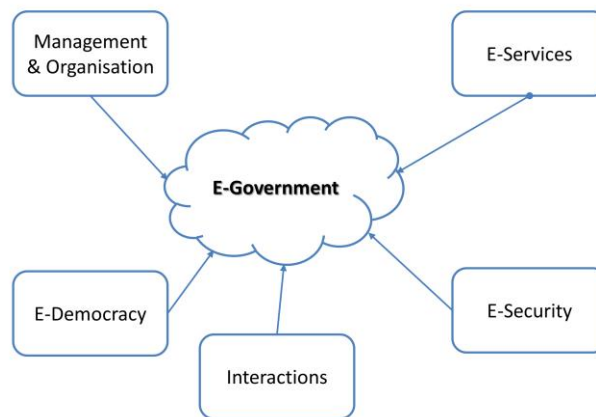


Figure 1: E-government perspectives for developing nations (Source: With modification from Lofstedt [18])

From figure 1, whereas e-government is conceptualized in various terms like e-democracy, interactions, e-security, management and organization, the point of departure for this paper is that citizen e-services comprise a key e-government service dimension for marginalized citizens. These are pre-requirements if the rest of the dimensions are to be utilized by citizens [19-20]. This is in support of Lofstedt [18] who reveals that current interest is however increasingly focusing on the demand-side (the individual citizen). Research concerning user-related issues is thus becoming more frequent [21-22]. Interest in the field has begun to shift from government at the national level where studies are more abundant to more citizen-related issues such as usability and user willingness [23]. This study posits, like other similar authors who observe that Information Technology (IT) and Information Systems (IS) related projects have lower utilization levels than other projects [24], that the challenge of citizens not willing to use e-government solutions still prevails. We therefore postulate that approaching the problem using a co-design approach for developing e-services applications may offer a solution [25-26].

From the reviewed cases, ICT when appropriated as e-government for citizens, has the ability to reduce poverty by improving poor people's access to education, health, financial services and public safety enhancement [27-30]. For instance, in India small scale farmers, artisans and Small and Medium Enterprises (SMEs) living in rural areas through their project '*computerized milk collection centers*' have enabled citizens to obtain access to information about prices, data on crops, weather conditions, credit facilities and market opportunities [31]. However, the design of such ICT projects in most developing nations, including Uganda, is characterized by a design-reality gap. This design-reality gap can be linked to the lens used to assess IS designs [5], [32]. Whereas there are a number of design science theoretical frameworks for the context of developing nations, a socio-technical approach is a viable theoretical perspective.

2.3 Socio-technical approach for IS project design

In a socio-technical approach, the focus is on the analysis of the problem and the formulation of the design in joint consideration of the technical system requirements and the social system requirements [24], [33]. It is further observed that this type of design process should not only consider procedural aspects of design but also people and change processes [34]. Design science research is an essential part of IS research as it has been argued that the IS field should not only try to understand how the world is, but also devise solutions of how to change it [34]. The authors reveal that the rationale for the use of a socio-technical design lens is that knowledge and theory generated from such an approach can support practitioners in understanding which mechanisms lead to desired outcomes.

The cornerstone of the socio-technical approach is that the fit is achieved by a design process aiming at the joint optimization of the subsystems i.e. any organizational system maximizes performance only if the interdependency of the subsystems is explicitly recognized [35]. Hence, any design or redesign must seek out the impact each subsystem has on the other, and planning must aim at the achievement of superior results by ensuring that all the subsystems are working in harmony but guided by socio-technical design theories. From a project management perspective this is critical to IS project success.

From a socio-technical perspective, the social aspect during design in the IS discipline is key. Henningsson et al. [36] observe that IS designers, with the ambition to provide socio-technical solutions to real world problems, require the contribution of external stakeholders to the development, testing, and implementation of the design contribution. These authors [36] analyze socio-technical IS design research from a resource dependency perspective. The resource dependency theory holds a notion that resources flow from the periphery of poor and underdeveloped states to a core of wealth states, enriching the latter at the expense of the former [37]. This makes the rich nations and rich individuals more enriched by way of integrating the poor into the developed world system [36, 37]. The need to achieve a balance between development and that of technological projects (e-government projects) whilst aligning developing nations with their citizenry's needs, is the precursor to mitigate the design-reality gaps.

2.4 The design-reality gap in e-government related projects

Heeks [5] observes that central to e-government success and failure is the amount of change between where citizens are now and where the government project wants to take them. The author argues further that the success or failure of e-government depends on the size of the gap that exists between the current realities and the design of the e-government project [5]. Heeks points out that Information, Technology, Process, Objectives and values, Staffing and skills, Management systems and structures, their resources such as time and money (ITPOSMO), are general dimensions not particular to a specific cohort in the e-government categorizations and that that bring variations in the design-reality gap.

Drury [38] has referred to them as a 5C Model of Context, Content, Connectivity, Capacity and Community. Sigwejo and Pather [6] in their E-government User Centric Satisfaction Framework (ECSF) have summarized them as functionality of service, motivation to use service, enabling infrastructure and government preparedness. The first two, functionality of service and motivation to use can be directly linked to users and government preparedness linked to policy.

Similarly, Peffers et al. [39], [40] have articulated a design gap as the lack of a conceptual model for how researchers and designers can carry out design work of IS (e-government) and mental models of citizens' evaluation of such services. By focusing on interrelationships between various contexts, citizen-centric design is a promising innovative design towards service usability [41-45]. Notwithstanding, e-government application design which is well thought out from inception has the potential to improve the lives of the undeveloped nations and their poor citizens.

2.5 E-government projects and citizen livelihood improvement

Heeks [4] warns that e-government is not merely computerization of government systems, but a belief in the ability of technology to achieve high levels of improvement in various areas of citizen service delivery. Whereas a number of studies perceive e-government as a subset of e-governance, this study conceptualises e-government as a pre-requisite for e-governance [46]. This is because e-governance consists of three components that are all very critical to citizens [4]:

- E-administration-improving government processes,
- E-citizens and e-services-connecting citizens, and
- E-society- building interactions with and within the civil society.

However, the issues related to livelihood improvement that yield effective adoption and usability of e-government are not well articulated. Similarly, Bhatnagar [47] notes that e-government has two complementary aspects: a political aspect, which focuses on enabling democratic participatory processes by engaging citizens. The second aspect is the technical aspect which focuses on government operations and processes. This conceptualization of e-government cannot elicit effective use of e-government from marginalised communities.

There is a need to address livelihood improvement issues as a key return to investment on side of government and socio-economic relevancy to citizens so that such applications are designed from a participatory approach that address citizens' needs to ensure usability. Soriano [48] conducted an Information Communications and Technology for Development (ICT4D) study in China and found that making tele-centers available in rural communities, does not guarantee that poor people will and can use them to create and share knowledge that could help lift them out of poverty. Whereas Vaismoradi et al. [66] found that to be the case, more developing countries like Uganda are deploying tele-centers, digital centers or Public Access Center programmes to provide information access to poorer rural areas in the hope that citizens would use them. Unfortunately, this has not been the case, and yet quite a number of authors reveal the link between effective e-government solutions use and community wellbeing [49-52].

2.6 Lack of citizen-centricity at the application and e-government service level in a G2C context

Evans and Yen [53] highlight challenges as obstacles in terms of e-government cooperation as dissimilarity in conditions, different objectives, inconsistent technology and differing levels of adaptability. Related to Evans and Yen [53] findings, Heeks [5] points out that e-government services are implemented as technocratic projects and with implicit assumptions that citizens will use them. To further the argument, Assimwe and Lim [54] reveal that from a government-citizen centric perspective, many government websites are seldom used, especially by people with disabilities. This is because visual and communication features, for example, are critical from a user perspective if usability is to be attained. These include, though are not limited to design consistency in web pages, visual design (font and color formatting), feedback/enquiry forms and interactive tools, page content sharing tools, zoom options and audio content [54]. Similarly, Kaisara and Pather [55] use a citizen evaluation continuum to highlight six service quality dimensions applicable in e-Government evaluation viz. website design, navigation, communication, site aesthetics, information quality and security.

From the aforementioned evaluations, the factors highlighted are user-centered features that may call for co-design especially for web application services as e-government applications. Cross cutting features from the literature are related to cooperation, dissimilarity in conditions, demographic characteristics, technicalities of projects, and lack of interactive forms, among others. These are challenges related to a lack of user centeredness at application and e-government service level in an e-government context [56]. These call for a focus on participatory design as a remedy to address the design-reality gaps.

3. Methodology

The study design was based on a Participatory Action Research (PAR) approach which harnesses the participatory design science research qualitative paradigm. There are two core elements of the research approach adopted in this study. Firstly, an underlying design science approach as suggested by Peffers et al. [39] and Hevner et al. [57], secondly the incorporation of co-design within an overarching case-study Yin [58] with embedded units [59]. It is embedded in the form that Uganda has a district governance structure and Mukono district is the focus area of this case study. There are also e-government policy makers and implementers as one unit of analysis and citizens in a health sector setting as another unit of analysis. This assessment at the supply side (government side) and the demand side (citizen side) provided an impetus for analysing the design-reality gap. The whole study process upon which this paper draws was iterative in nature and details of the two case studies are provided in the subsequent sections.

3.1 Iterative Co-Design Research Model

This paper is guided by the **Iterative Co-Design Research** model abbreviated as **IcoDeRe** (Figure 2) featuring Design Research 1 (DR1), Design Research 2 (DR2), Design Research 3 (DR3) and Design Research 4 (DR4).

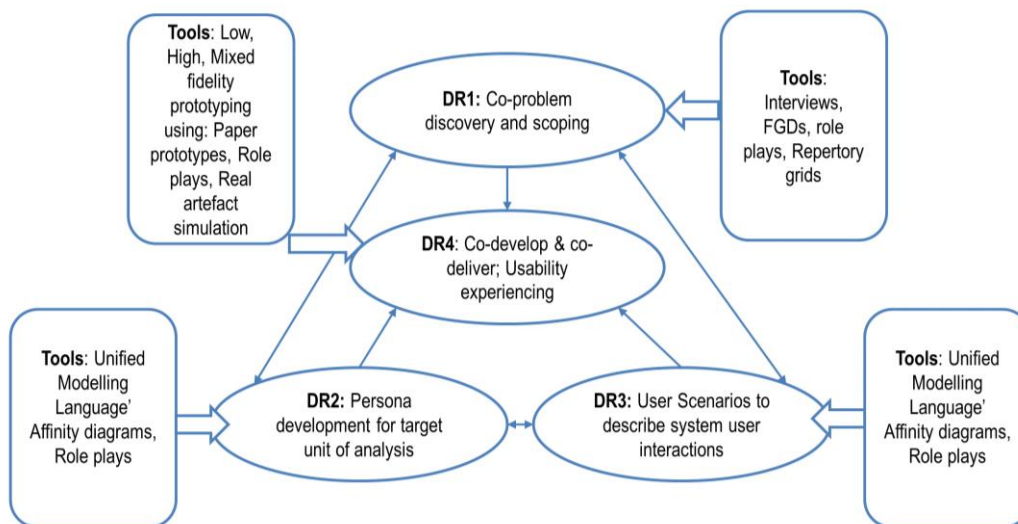


Figure 2: Iterative Co-Design Research (ICoDeRe) Model

The guiding model was constructed from design thinking principles with the purpose of revealing points of convergences and divergences in relation to the design process. In the divergent mode at DR1, the co-design team openly identifies all views, problems and potential impacts of the intervention being planned. In the convergent mode, the team hones in on viable scenarios for users with a view to create buy-in amongst stakeholders for the change process being sought.

3.2 Establishing the parameters for problem discovery and scoping

This paper reports on Design Science Research 1 (represented as DR1 in Figure 2) at the policy level and which mainly comprises of co-problem discovery and scoping. The researchers and a design team ascertained a class of problems that affect marginalized communities in Mukono District of Uganda. These were scoped through both interactive and iterative processes. At the problem discovery phase, problems from a user perspective were perceived in practice based on their lived experiences in the communities. This was followed by an assessment of the current state of affairs in respect of how e-government policy makers arrive at the e-government projects and interventions they design for

citizens. This in turn provided the impetus for formulating the research effort and articulating the design-reality gap. It is noted that the input for this formulation can come from practitioners, end user communities, the researchers, existing technologies, policy makers and/or review of prior research [57]. Some scientists have argued that the problem formulation stage identifies and conceptualizes a research opportunity based on existing theories and technologies as well for a given case study context [58].

3.3 Case study approach

Yin [58] notes that a case study method is appropriate when a researcher wants to address either a descriptive question like (what happened?) or an explanatory question (how and why did something happen?). Yin [58] further comments that compared to other methods, the strength of the case study method is its ability to examine in-depth a case within its real-life context. Second, case studies are revealed to be appropriate when a researcher wants to illuminate a particular situation, to get a close in-depth and first hand understanding of it. Gerring et al. [59] re-affirms that the case study approach is a method of evidence gathering that is natural, that the researcher investigates the properties of a single phenomenon, instance or example.

In the software engineering context, the case may be a software development project, which is the most straightforward choice or it may alternatively be an individual, a group of people, a process, a product, a policy, a role in the organization, an event, a technology, etc. [60]. Benbasat et al. [61] argue that even though a study appears to be a single-case, embedded unit of analysis, it could be considered a multiple-case design, due to the decentralized nature of the study sites.

In the broader study from which this paper draws, we followed Benbasat et al. [61] and Yin's [58] notion of embedded case studies where multiple units of analysis are studied within a case [61], [63-65]. Two of those cases are the e-government policy planners and implementers and citizens in the health sector pilot case unit as a co-problem discovery and scoping case within Mukono District, Uganda.

Case unit one: e-government policy officials and e-government policy documents

As a way of understanding e-government policy related issues, the researcher undertook purposive sampling of key informants (Table 2), where eight key government officers were sampled. The collection of evidence involved a focus group discussion among five e-government application designers (software developer, database administrator, business process officer, manager business process and ICT officer) as well as one-on-one semi-structured interviews. Additionally, sixteen (16) e-government policy related documents and websites were reviewed in order to establish the status quo regarding available e-government projects and related citizen interventions [31], [66-80]. The objective of the review was to examine whether there were successful citizen e-government projects, if any, as well as notable failures, crises, extreme cases of wither problematic and good e-government scenarios. The same criterion was used to sample government websites for review and for data triangulation and verification.

Case unit two: Rural Health Hospital

Table 2 highlights this unit of analysis that formed a pilot phase of the project. The rationale for this selection is that most of the e-government interventions are geared at deploying ICTs to improve health service delivery. In other words in Uganda, the health sector is one of the sectors where a number of e-government projects and efforts are focused. We aimed to examine the extent to which the planned e-government health related projects are aligned with citizen's needs and aspirations. The method used to collate data was a focus group discussion that comprised 40 diverse citizens. These citizens were purposefully selected because of their position and influence in the communities they hailed from. They included representatives from the religious sector, motor cyclists leaders, village health teams, community elders and community group representatives. Table 2 depicts a summary of the respondents of the study.

Table 2: Respondents category for interviews and focus group data

Respondent category	Number (N)	Gender	Sampling rationale
Government officers (Interviews)			
Rural Communications Development Fund (RCDF) Manager	1	Male	Key informant in charge of rural technology
Ministry of ICT (Permanent Secretary and Personal Assistant to the Minister of ICT)	2	Male	Key informants in charge national ICT policy
Business Process Specialist MoICT	1	Female	Key informant FGD for district ICT development
Software Developer MoICT	1	Male	Key informant FGD for district ICT development
Database Administrator MoICT	1	Male	Key informant FGD for district ICT development
ICT specialist MoICT	1	Male	Key informant FGD for district ICT development
Programmer MoICT	1	Male	Key informant FGD for district ICT development
Health setting stakeholders Focus Group Discussion (FGD)			
Hospital Board Members	5	2 Males 3 Females	Key informants
Hospital staff (Nurses and doctors)	5	3 Males 2 Females	Key informants
Village Health Teams members	20	10 Male 10 Females	Key informants
Clergy and religious people	5	2 Male 3 Female	Key informants
Motor cyclists stage managers	5	Male	Key informants

From table 2, the selected government officer stakeholder group is at the core of design and implementing citizen applications. They included rural communications development fund project officers and Ministry of ICT officers. This helped in the analysis of the gap between the supply and demand side of e-government for citizen applications.

3.4 Qualitative data analysis process

From both case studies, the data was analysed using Thematic Content Analysis (TCA) whilst combining content and thematic analysis. Thematic content analysis is conceptualized as a descriptive presentation of qualitative data [64]. Bloor and Wood [63] note that the purpose of content analysis is to describe the characteristics of the document's content by examining who says what, to whom and with what effect. Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data [65]. This study combined the two analysis methods given that Vaismoradi et al. [65] observed that the two share the same aim of analytically examining narrative materials from life stories by breaking text into relatively small units. The researcher grouped and distilled from the texts a list of common themes in order to give expression to the communality of voices across participants. Every attempt was made to employ names for themes from the actual words of participants (in-vivo descriptors) and to group themes in a manner that directly reflects the texts as a whole.

4. Results and discussion

From the Ministry point of view, project interventions under the Ministry of ICT strategy direction that are aimed at citizen's engagement with government are related to e-procurement processes, e-health, e-tax, and e-education [68]. Whereas e-procurement is a key intervention, it is not an e-service required directly by the underserved (marginalized citizens). This was ascertained from the focus group interview results in which the stakeholders within the health setting, never identified e-procurement as an application of concern based on the rural health sector needs. Another intervention of concern to the side of government is public health reporting. However, the e-government strategy based on the interviews with the officers was not precise as to what such public health requirements should be and called upon universities and private sector innovators to take it on as a point of concern. This was revealed during interviews with the Rural Communications Development Fund (RCDF) manager and an officer from Ministry of ICT, Uganda. When these respondents were interviewed as regards to government support to universities to innovate in support of citizen-

centric application development, the officers noted that government does not solicit projects and only delivers based on their strategic plans and national priority areas.

As regards to the extent to which citizens' aspirations and needs are incorporated into the G2C e-government strategy, this is a glaring design-reality gap as government showed no commitment to funding whatever comes from citizens. Such a design scenario concretizes the view that e-government design for citizens takes a top to bottom approach. For instance one of the officers commented,

“Government has meagre resources that cannot be directed to fund any proposals that are generated from citizens. We follow our Master designed roadmap bearing what we think works for the general community and funds will only be directed towards that.”

Moreover, when it comes to private sector to reach ICT related services to rural communities, the officer commented that it is not viable to extend services to such areas by telecommunication companies since such ventures are not profitable. He commented,

“Business you understand, a company will not try and put 3G or 4G internet in the village since it is not viable at all. Many telecom companies have opted to serve the urban areas but we as government are trying to get the best requirements for the locals but we are still failing.”

With regards to explanatory issues of the conceptual divergences of citizens' requirements and government's requirements for e-government strategy design, it was revealed that resource allocation against set strategy was a key issue on the side of government. For citizens, their aspirations and mental models are in line with effective engagement with government as regards to issues of community well being, safety and security featuring reduced crime, fire outbreaks, sanitation, kidnaps and hard to reach effective transport booking systems. In the health sector where public health seemed to be a compatible problem between government and citizens' aspirations, citizens (client's interest) requirements were linked to online booking and complaints reporting systems for better service delivery improvement.

As e-government interventions, the point of convergence between the designers and government within the e-government national strategy was the nurturing of innovation and development. The officer commented,

“It is good that you are working with youth in the Universities to think aloud and develop IS interventions that speak to the citizens' needs. However, as Ministry, we shall be able to point and support those that are in line with our strategy due to resource constraints. However, the desire would be to fully implement whatever comes from the citizens but we cannot. However, we appreciate the need to work with private partners to serve citizens better.”

Whereas policy documents highlight some issues related to government being citizen-centric, there are no deliberate operational strategies to effect such a policy envisioned and a lot of designed projects meant for citizens have turned into 'white elephants' [66-68]. Furthermore, from the health sector, the Uganda National e-healthy policy [69] observes that the Ugandan health sector is characterized by a fragmented landscape of ICT pilot projects and numerous data and health information system silos with significant barriers to the effective sharing of information between healthcare participants. The policy further reveals that although the government, partners, and private institutions are continuing to invest in various ICT initiatives, without some form of a national plan and coordination, there is a real risk of continued duplication, ineffective expenditure, and the creation of new solutions that cannot be integrated or scaled across the continuum of care.

A focus group interview with the five application development team members also noted that there is a lack of well documented citizen centric commitment towards design of most e-government application. The group noted,

“Whereas we want to design solutions for the locals, we actually have not known what such locals’ need. The Business Processing teams try to generate those needs but still, most times, our e-government interventions and projects have fallen short of such citizen groups.”

Such results from e-government policy makers and implementers render support to the Chaos report [4] that points out that user involvement features in the top 20% of the metrics for projects that are successful, yet such a metric is neglected at the government design side. The results from the policy makers viewpoint contravenes the socio-technical approach whose focus is on the analysis of the problem and the formulation of the design in joint consideration of the technical system requirements and the social system requirements [24], [33]. This paper observes that such a design loophole is a design-reality gap.

To examine such a design loop hole from the citizen demand side, focus group discussions with the rural health facility hospital, too, revealed divergent views as to how ICT could be applicable in their contexts of a resource constrained environments. The leading question for the problem discovery phase with staff, selected clients and stakeholders was: *“How can a hospital in a resource constrained environment maintain health service delivery at a low cost and yet enhance service accessibility and affordability to the poor population served?”*

The purpose of this question was to enable stakeholders to document and reveal innovative ways of ensuring that health service are viable and affordable access among the citizens.

The focus group discussions comprised eight groups with at least n=5 participants each totalling to n=40 participants.

Table 3 shows the results of the thematic content analysis and categorization. The themes represent ways for improving service delivery while making health care affordable to the indigent.

Table 3: Themes from the eight focus group discussions of the health setting stakeholders

Themes	Frequency counts (n=8 groups)
Design strategies for insurance and medical benefits	4
Hospital should undertake school health visits	3
University students medical services should be covered by hospital	2
Fliers need to be printed and distributed	2
TVs, radio and newspaper advertisements need to be placed	4
Project proposals to funding agencies	5
Hospital website featuring a Doctor booking form and a client complaint form should be designed	6

Source: Focus group discussion transcripts

Most of the group themes evidenced the need for an online web based system and they include:

*“Private wing needs to be furnished with online booking services to improve accessibility and timeliness of care giving so that more private patients are attracted all over the country to enhance **revenue** for offering sustainable services to the other non-paying patients.”* (Group presenter emphasis)

Similarly another focus group comments was,

“The hospital has done enough to put in place medical equipment, we now need effective use. Let’s put our services online to a wider community, be transparent and accountable to our donors and other partners, this will yield us more resource support.”

A retired civil servant accessing services from the hospital revealed that,

“As a private patient, I want to come to hospital and find my medical record sorted than being asked over and over again, so let’s put services online than making us stand in line here.”

The results of the Focus Group Discussions (FGDs) are contrary to the modernization theory and render support for the resource dependency theory by arguing that the *haves* should be at the fore front of spurring development to create a spill over effect to the *have-nots*. Such spill over effects leads to improvement in health care giving to the poor citizens and communities [70-73]. From the literature, similar submissions have been made that include: Patient complaints help to identify problems in patient safety and quality of clinical care [72]; effective complaint handling systems aid in the generation of recovery strategies on a hospital’s revenue and profitability, dramatically and efficiently [73]; Implementation of patient care information systems is a potential means to achieving medical error reduction [70] and a reciprocation between theory and practice [74], among other benefits.

During the plenary discussion of how such an online web based system would be of benefit to the marginalized, the following themes came forth: Web based applications aid patient centeredness; Patients are given more freedom in decision making about their preferences for the appointments and to have improved access; Improve online offerings to patients who can pay so that the over 70% of poor non-paying citizens will have better services delivered to them as well. For instance, one private patient paying Ugshs 300,000 (equivalent to 80 US dollars) can in effect subsidise 30 patients who are charged user fees of Ugshs 10,000 each (equivalent to 2.68 US dollars). Therefore, one paying patient whose service satisfaction is improved through ICTs can offer a contribution to over 30 non-paying patients. This creates a positive spill over resource effect (externality) i.e. intangible benefits of ICTs as opposed to well known tangible ones to the economically marginalized citizens.

Finally, our findings turn to the *Design-reality gap*. Whereas government and e-government policy design teams have their conceptualized designs like online birth registration system and clinical information (health informatics), provision of health services at a distance (tele-health), sharing information and knowledge with health care providers (e-learning) among others as per the Uganda National e-healthy policy [69], the citizens had a different perspective in terms of problem priority. This therefore points to the need for the design teams and e-government policy designers to undertake participatory problem discoveries and scoping during project designs. Kristensson et al. [73] offer support for the results of the co-discovery phase where they note that participants need to be exposed to problem discovery methods that give them the freedom to put their views across based on their own pressing needs, rather than going with pre-configured problems for design for them to rubber stamp. Sanders and Stappers [41] too offer similar guidance and argues that co-design in a broader sense should ensure that designers and people not trained in design, collaboratively work together in the design development process from problem definition phase to determine design outcomes. Van de Ven and Johnson [74] emphasize that such cooperative working is the most critical way in which the gap between theory and practice can be bridged.

5. Conclusions and recommendations

This paper concludes by offering recommendations as per the final research objective of proposing a framework that can underpin such divergences in order to bridge the design-reality gap and develop citizen centric projects especially for citizens. The recommendations emanate from the conclusion that there is a design reality-gap where citizen’s conceptual models are not aligned with government citizen e-government strategy due to absence a deliberate targeted strategy. The concept of “*give them, they will come*”, has not resulted into usability and government leaders have ended up disappointed. For instance, at The Hague Organization for Economic Cooperation and Development (OECD) conference [77], the leaders agreed that countries are struggling to better meet user expectations, but few have the necessary and sufficient knowledge of these expectations.

This paper recommends that co-creation of e-government applications services and projects with citizens in a bottom-up approach, will lead to proper integration of citizens’ needs and assumptions into the design. Hence, this results in

effective use of such applications and programmes. However, citizen centric design needs to be preceded with well designed co-problem discovery and scoping phases with citizen stakeholder groups following a theory of change. We therefore propose that governments in developing contexts should adopt a Government to Citizen and/or Citizen to Government (G2C/C2G) design-reality gap theory of change (Figure 3).

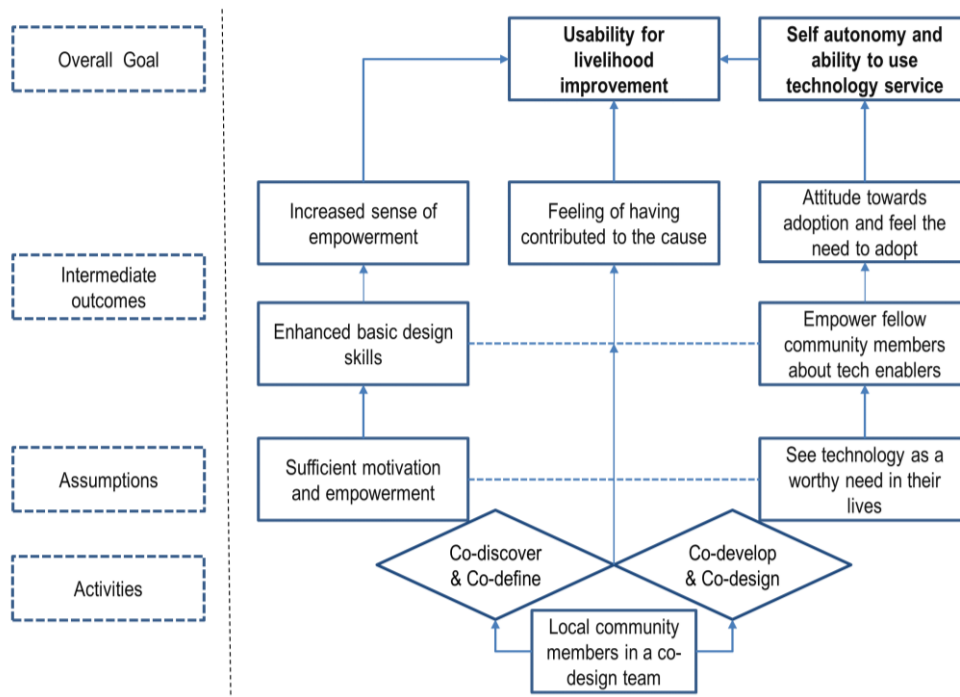




Figure 3: G2C Design-Reality Gap proposed Theory of Change

Legend: Co-Design processes 
Project activities, assumptions and goals 

From the above framework, when a group of citizens from a local community form a co-design team, their current realities are most likely to be incorporated and embedded in the artefact and project design. The activities elicited from the co-discovery phase in turn shape the scoping at co-definition phase. The diamonds are used to reveal points of divergences and convergences between the designers’ conceptual models and citizens’ mental models as has also been used by the British Design Council and applicable during design thinking initiatives. When in divergent mode, quite a number of beliefs, attitudes, assumptions, are revealed from the participatory approach. Furthermore, co-scoping leads to mental convergences between citizens and designers. This is followed by co-development with low fidelity prototypes and presentation of actual artefact to yield further insights into the design based on the citizens’ own application evaluation criteria. However, the participating citizens need to have sufficient motivation, empowerment and self-realisation that the project under development is a worthwhile need in their lives.

At the activity level, there are measurable immediate results (outputs) coupled with intermediate results (outcomes). These may include but are not limited to: enhanced basic computer skills, technologically empowered citizens (technology savvy citizens), feeling of the need to use and adopt technology which ultimately contributes to the overall goal of ICT4D in terms of usability and continuance to use technology for livelihood improvement. The realisation of

the highlighted results chain may make a contribution to the National strategy set by the Uganda Ministry of Information and Communications Technology, to ensure the alignment of the e-government strategy [78], [79], [80] to the real pressing needs of the citizens. In other words, this may ensure that what is well documented in national policy documents but not implemented, is actually realised.

Such national alignments will contribute to the Global ICT mandate as documented in the World Summit on Information Systems [79] that calls on nations to re-think their ICT design mentality of “*build-it and they-will-come*”. This is under the World Summit on Information Systems (WSIS+10) [79] action line C2 and C3 which challenges governments to provide rural people access to ICT infrastructure and Internet in order to move them into the digital society. However, the summit reveals that this has not worked at all and governments have been disappointed. This therefore underscores the recommendation of this paper to embed participatory design approaches and methods to develop e-government systems that will have inherent citizen value. Finally, to attain a more robust and successful e-government project implementation, we argue that there is a need to collaboratively align information systems development with best practice standards for Project and Program Management (PPM). Similarly, Teubner, [81] has re-affirmed that academic research on IT related Project and program management is still at its infancy and needs to be enhanced to improve practice. Through the participatory design approach that is proposed, we render support to authors who recommend measuring project success in the eyes of the customer [6, 41-45, 54, 81], or rather the citizen user, as is the case in e-government projects.

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Megaproject complexity attributes and competences: lessons from IT and construction projects

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Megaproject complexity attributes and competences: lessons from IT and construction projects

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Abstract:

Megaprojects have been associated with persistent underperformance technically, financially, socially and environmentally. This underperformance has been attributed to the inherent complexity attributes and the gaps in the form of the mismatch in the project management competences and processes used by the project management teams to deal with the complexity attributes. This study seeks to investigate the performance implications of these complexity attributes to recommend suitable management competences for the successful delivery of megaprojects. This conceptual study used an integrative literature review to analyze and synthesize findings from existing scientific articles related to the complexity constructs based on a comparative assessment of Information Technology (IT) and construction megaprojects. The Complex Adaptive Systems (CAS) Theory was also used to highlight some of the factors that influence megaproject performance towards identifying suitable management processes and competences, which are required to deal with megaprojects complexity. The key findings include a nomenclature of the main complexity attributes, their implications on the performance of IT and construction megaprojects, and, lastly, the management competences and processes that are required to deal with the complexity attributes for improved megaproject performance.

Keywords:

competences; complex adaptive systems; complexity attributes; megaprojects; management processes.

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1. Introduction

Megaprojects have been found to play an important role in the economic development of a nation directly and indirectly, through different multiplier effects [1-3]. Some of the most commonly cited socio-economic benefits of mega infrastructure investments include improved global connectivity, access to natural resources, competitive markets, and better job opportunities [4]. This is supported by studies in both the developing and the developed countries [5-7]. For instance, intensive capital investments in megaprojects in China have been associated with high rates of economic growth and, consequently, an upliftment of close to half a billion people above the poverty line between 1980 and 2000 [8]. While the importance of these developmental benefits cannot be overemphasized, megaprojects have also been found to have a tainted history of poor performance [9-11]. This poor performance has been espoused from technical, financial, socio-economic and environmental perspectives [12-13]. Additionally, the poor performance has been found to undermine the socio-economic, political and environmental benefits that could potentially be derived from megaproject investments [14]. The impacts of megaproject poor performance have been found to be, particularly, direr in the developing countries, where there are neither the necessary resources to absorb the associated shocks nor the required capacity to sustainably recover [8]. Consequently, it has become imperative to establish some of the failure factors involved, recommend suitable remedial measures that can contribute towards improving the performance of megaprojects and, ultimately, enhance their potential developmental impacts.

This study discussed these aspects based on experiences drawn from megaprojects that have been implemented in the Information Technology (IT) and construction sectors. The choice of these two sectors has been informed by considerations such as the amount of research that have been conducted to date and their contribution to the gross domestic products (GDP), particularly, the GDP of developing countries [12]. Research projects which have been conducted regarding the project management experiences during the planning and implementation of construction and IT megaprojects have revealed some gaps and important lessons which can be applied in other similar projects. For instance, with reference to the Brazil, Russia, India, China and South Africa (BRICS) economic group, the IT industry and construction industry have been found to, respectively, contribute about seven percent (7%) and six percent (6%) of the GDP [15]. This is an important value addition, which can be further enhanced through an improvement in the performance of the associated megaproject investments. This study aims to establish some of the factors that impact the performance of megaprojects and recommend suitable management processes and competences that can equip project teams to improve on the delivery of megaprojects. The three objectives include to: (1) establish the main factors causing poor performance of megaprojects; (2) recommend suitable management processes and competences for improving megaproject performance; and (3) determine the implications of improved megaproject performance for the developing countries. The findings from this study, therefore, contribute to the existing body of knowledge regarding project management and, particularly, megaproject delivery. The findings also provide important insights into megaproject attributes, their implications on performance, and the suitable project management processes and competences to address the challenges associated with the current project management approaches.

2. Background

For a proper contextualization of the preceding aim and objectives of this study, this section discusses the main constructs which have been addressed under this study. The first construct is megaprojects. This study discussed some of the current debates surrounding the conceptualisation of megaprojects, the current trends in global investments in megaprojects, and some of the key factors that have been found to impact the performance of megaprojects, particularly, the complexity attributes involved. The second construct is IT and construction megaprojects. The study undertook a comparative assessment of the findings from past research projects, which have been conducted across the IT and construction sectors to draw plausible generalisations for application in the delivery of similar-sized megaprojects. The third conjoined construct had to do with the management processes and competences required to deal with megaproject complexity to improve performance. Lastly, this study also incorporated a geographical distribution aspect to provide the necessary demographics of the different IT and construction megaprojects as an essential part of the analytical framework of this study.

2.1 *Megaprojects as a developing phenomenon*

The term “megaprojects” has been construed as an old phenomenon which dates back to the prehistoric times when ventures such as the Pyramids of Giza in Egypt, the Roman Colosseum in 80AD and the Great Wall of China were built [16]. The term “mega” originated from the Greek word “megas” which means “great, large, vast, big, high, tall, mighty or important” [17]. The term “mega” was found to have been initially used in relation to megacities in 1968 [10]. Subsequently, from around 1982, the term has been used loosely as a stand-alone adjective to refer to any large project [18]. Scientifically, the term refers to a measurement of worth that is expressed in millions. Using this scientific logic, it can be argued that megaprojects are endeavors worth millions of, notably, dollars, pounds, and euros [19]. Accordingly, this perspective has been used to define and delineate projects such as the Roman Colosseum, the Great Wall of China, and the Pyramids of Giza in Egypt, which were implemented in the past centuries [17]. The situation has since afterwards changed due to the evolutionary cycles associated with megaprojects [10]. Some important events which have been credited for transforming the megaproject landscape have been found to include the Second World War, the Cold War and the Space Race, which ushered megaprojects such as the Manhattan Project (1939 to 1946), and the Apollo Program (1961 to 1972), whose budgets have been estimated to be worth several billions and trillions of dollars [20]. Based on the scientific interpretation of the term “mega”, these important events-borne projects should ideally be termed “gigaprojects” and “teraprojects” based on the sizes of their budgets [5]. However, the terms “gigaproject” and “teraproject” have not been found as being used in the existing literature [19]. Instead the term “megaproject” has been used generally to refer to any massive project, without any attachment to a scientific meaning [12].

From the subtle dichotomy between the literal and scientific conceptualizations, megaprojects have been construed differently by different authors. The most commonly cited reason is the fact that megaprojects are large scale undertakings which require huge budgets and are delivered through complex multiple partnerships between the private and public sectors [21]. As a result, a broader definition of megaprojects has been provided by the United States’ Federal Highway Administration (FHA) as “... projects of a significant cost that attract a high level of public attention or political interest because of the substantial direct and indirect impacts on the community, environment, and state budgets” [22]. Additionally, the Major Projects Association (MPA) included the dimension of competence by defining megaprojects as “... projects which require knowledge, skills or resources that exceed what is readily or conventionally available to the key participants” [16].

Based on these different definitions, what constitutes megaprojects has been concluded as being, largely, elusive and constantly developing phenomena [23-24]. Additionally, the several debates around the key properties of megaprojects have influenced their conceptualization [21]. For instance, on the one hand, some authors have argued that most views regarding megaprojects have been influenced by the contexts within which either the projects are located or the environments under which the associated studies are conducted [25]. On the other hand, it has also been posited that the current conceptualization of megaprojects has been heavily influenced by the disproportionate number of studies which have been conducted in the developed countries as compared to those in both the emerging markets and the developing countries [20, 26]. Additionally, other researchers have cautioned against drawing broad generalizations of the term megaproject for application in the emerging markets and the developing countries contexts [21]. As a result, it has been accentuated that the generally applied USD 1 billion budget threshold is rather arbitrary and, hence, not universally applicable across different socio-economic and spatial settings [23].

By following up on this logic, it has been advanced that the average budget sizes of megaprojects such as the International Space Station, the Joint Strike Fighter and the United Kingdom high speed rail system, surpass the GDP of countries such as Kenya, Guatemala, and so on [21, 23]. In order to have a realistic perspective across both developing and developed countries, it has been posed that contextual aspects such as the ratio between the megaproject budget and the host nation’s GDP must be taken into account [20, 23]. Consequently, it has been suggested that any project with a cost-GDP ratio of about 0.02% in the contexts of both the developed and the developing countries should qualify to be categorized as a megaproject [27]. By applying this approach, infrastructure projects in Eastern Europe with average budgets of between EURO 100 and 250 million have been categorized as megaprojects [28]. This cost-GDP ratio approach has also been proffered as a way of evaluating the risk exposure levels associated with megaproject investments, particularly in the developing countries with low GDPs. This study supports such an approach as a useful

way of informing governments in the developing countries regarding possible exposure in the event of megaproject failure. This is, particularly, important given the proliferation of megaproject investments in countries such as South Africa, Nigeria, Ethiopia, Kenya, Tanzania, and Morocco, among the other developing countries [29-31].

Another related debate has focused on the key factors behind the underperformance of megaprojects [5, 32]. Among the many factors that have been put forward in the literature, project size and complexity levels have emerged as two of the most common and impactful factors [33-37]. It then follows that by using project size and the degree of complexity involved, megaprojects (large and complex) have been categorized into small projects (small and non-complex), large projects (large and non-complex), and complex projects (small and complex) [26] (Figure 1).

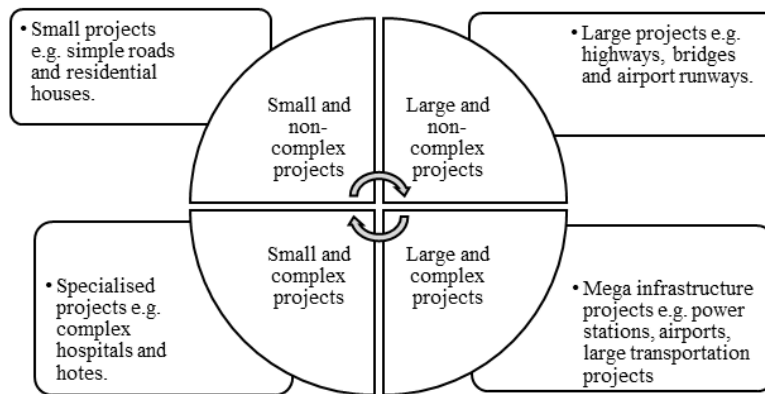


Figure 1. Project Typology based on Size and Complexity (Adapted from [27]).

In an attempt to further simplify the conceptualization, megaprojects have been defined broadly under the investment, operations and economic perspectives [20, 27] as discussed subsequently. Firstly, the investment perspective delineates mega infrastructure projects based on issues such as the size of budget, technological components and the levels of innovation involved. Secondly, the operations perspective covers aspects such as the implementation timeframes involved and the environmental impacts. Lastly, the economic perspective focuses on the contextual issues which affect or are affected by the project [22]. Based on these views, this study upholds the inclusion of contextual aspects in megaproject delineation, regardless of the attributes used.

2.1.1 Trends in megaprojects investment

Megaprojects have been viewed as a preferred business model for delivering goods and services, a strategy for fostering economic growth, and a platform for advancing global connectivity [1-2, 29, 38]. This has been underscored by the increasing investment in megaprojects globally. From a construction sector perspective, series of megaprojects have been implemented across the world (Table 1).

Table 1: Some of the World's Largest Megaprojects

Megaproject	Country	Description	Cost Estimate
International Space Station.	USA, Russia, Japan, Canada and Europe.	Considered as the most expensive single item ever built.	\$150 billion (as of 2010)
Al Maktoum International Airport.	United Arab Emirates.	Considered to be world's largest in terms of size and passenger volume with capacity to land four jets simultaneously.	\$82 billion
South-to-North Water Transfer Project.	China.	Built to divert water from the Yangtze River using three huge canals to bring it to the north of the country Considered to be three times more expensive than the Three Gorges Dam.	\$78 billion (as of 2014)
California High-Speed Rail	USA.	Designed to link San Francisco to Los Angeles over a distance of about 1,300 km.	\$70 billion
Dubailand.	United Arab Emirates.	Mega theme park with the world's largest hotel (6,500 rooms), sports venues, eco-tourism, science attractions, and a giant mall to open in project will open in 2025 in Dubai.	\$64 billion
London Cross-rail Project.	United Kingdom.	Part of London's expanding underground system, with 42 km (26 mi) of new tunnels to connect 40 stations. To be complete by 2020.	\$23 billion
Beijing Daxing International Airport.	China.	This airport megaproject will have seven runways and the largest terminal in the world. Designed to help ease the load on nearby Beijing Capital International Airport and will open in 2025.	\$13 billion

(Source [10, 12, 28])

From the IT sector's perspective, some of the megaprojects that have been rolled out includes deep ocean marine fibre optic networks whose footprint has been found to be continuously growing [39-41]. It has been reported that in 2016, a total of 354 submarine cable systems were active, under construction, or expected to be fully-funded with the aim of linking and increasing communication efficiency across Africa, North and South America, Asia, Australia and Europe [39, 42-43]. The network has been projected to continue growing, particularly, in the light of the strong investment drive by companies such as Google, Huawei Marine, and Microsoft [43], with a number of projects being rolled out over the past few years (Table 2).

Table 2: Some of the Recently Constructed Submarine Cable Network Projects

Project	Description	Length (kilometers)
Sea-Me-We 5.	Links Asia and Europe.	20,000
Hawaiki Submarine Cable.	Links Australia, New Zealand and the USA.	14,000
Monet	Links the USA and Brazil.	10,600
Australia West Express.	Links Australia and Djibouti.	10,100
South Atlantic Cable System.	Links Brazil and Angola.	6,200
SemanticNet Fiber Atlantic.	Links the USA and France.	6,675
MAREA.	Links USA and Spain.	6,600
CamTel and China Unicom.	Links Brazil and Cameroon.	6,000
Indonesia Global Gateway.	Links Indonesian and Singapore.	5,300

(Source [11])

In the African context, other megaproject investments in the information and communication technology (ICT) sector have been construed in terms of innovation hubs such as the Kigali Innovation City (Rwanda) [38], Konza Technology City (Kenya) [5, 48], Yabacon Valley (Nigeria) [49], and the proposed Sheba Valley (Ethiopia) [50]. These innovation hub megaprojects have been planned to serve purposes including acting as research centres and information hubs. Although some of these megaprojects such as the Konza Technology City have encountered major implementation challenges and slow progress [5], others such as the Kigali Innovation City have progressed well [38].

Among the other socio-economic objectives, investments in megaprojects in the developing countries have generally been conceptualized as a deliberate strategy to foster economic growth [2, 18, 29, 31]. For instance, infrastructure-led development policies have accounted for China's high rates of economic growth between 1980 and 2000 [31]. Apart from the direct socio-economic benefits such as job creation and poverty alleviation, intense mega infrastructure investments has also been contributed towards the achievement of the United Nations' Millennium Development Goals

(UN MDGs) across the BRICS nations [52]. From a business perspective, the annual global mega infrastructure project market has been estimated to be worth between USD 6 and 9 trillion, which is approximately 8% of the global GDP [53]. Consequently, the need to tap into this lucrative business has also been advanced as one of the key drivers of the global spread of megaproject investment by multi-national construction and funding institutions [54]. This trend is one of the factors that has transformed the perspective of megaprojects from being the preserve of a few rich countries into a global phenomenon with a rapidly expanding footprint even in the developing countries [55]. Additionally, the growth in megaproject investments has been underpinned by the projected economic returns of between 5% and 25% of the infrastructure investments [40]. This estimated return on investment (ROI) has been found to resonate well with governments in the emerging markets and the developing countries in Africa, Asia and South America, where infrastructure-led development models have increased over the years to bridge the infrastructure deficits associated with increasing population and rapid urbanization [55].

Little wonder, then, that the prioritization of megaproject investments nurtures global competitive platforms for attracting and allocating foreign direct investments (FDI), including the underlying ideas and philosophies [56]. Under the logic of FDI and on the one hand, developing countries have leveraged on the natural resource endowments to position themselves as potential growth engines that are attractive to global megaproject investors [51]. On the other hand, developed nations have been found to extend their ideological influence through certain qualifying conditions which they often tie to infrastructure funding such as the Overseas Development Assistance (ODA) and Structural Adjustment Programs (SAP) [57, 8]. It then follows that the rise of powerful emerging economies such as BRICS and the increasing role of institutions such as the BRICS Development Bank in the global megaproject market is radically transforming the ideological landscape, particularly in the developing countries [51-52]. Most notably, China has been investing in several megaprojects in Africa through initiatives such as the Belt and Road Initiative and the China-Africa Forum for Cooperation [8, 31, 58] (Table 3).

Table 3: Chinese-funded Megaprojects in Africa

Country	Megaproject	Project Cost	Project Status (as at date)
Kenya.	Mombasa-Nairobi Railway.	USD3.2 billion	Completed
Nigeria.	Coastal Railway.	USD11.17 billion	Completed
Ethiopia.	Addis Ababa to Djibouti Railway.	USD4 billion	Completed
Tanzania.	Bagamoyo Megaport.	USD11 billion	Planned
Algeria.	The Great Mosque of Algiers.	USD5 billion	Planned
Egypt.	New Cairo.	USD35 billion	Planned
Congo-Brazzaville.	Pointe-Noire Special Economic Zone.	USD4.5 billion	Planned
Angola.	Lobito-Luau Railway Link.	USD1.8 billion	Completed
South Africa.	Modderfontein New City.	USD8 billion	Planned
Kenya, Uganda, Burundi, Rwanda.	East African Railway.	USD15.5 billion	Under construction
Zimbabwe.	New Parliament Building.	USD0.46 billion	Under construction

(Source [2, 30, 58])

The trends in global megaproject investments, accompanying the influx of FDI, have been used to categorize emerging economies into four groups based on their levels of institutional, infrastructure and factor market maturity [59]. The first group, which is central to this study consists of economies such as those from the Sub-Saharan Africa, which have been found to be characterized by poor institutional structures and low infrastructure and factor market development [22, 60]. These countries have been found to struggle with high infrastructure backlogs due to stunted economic growth, failure to attract alternative forms of infrastructure project funding, and the resultant overreliance on insufficient central and local government budgets [6, 60]. Many of these countries, especially those with vast natural resource endowments have been found to be the prime destinations of Chinese megaproject investments [4, 30, 58].

The second group consists of emerging economies in Asia and Latin America, which are relatively well-endowed with infrastructure and factor markets but suffer from inadequately developed institutions [7]. The third group includes mid-range emerging economies such as India, where well-advanced institutions have not been complemented with adequately developed infrastructure and factor markets and, hence, local companies have been stifled growth-wise and

forced to migrate globally [61]. The last category includes highly successful countries such as South Korea and China, which have been found as having advanced institutions, modern infrastructure, and mature factor markets that enable their competitiveness to lie in the continuous improvements of their value chain [7]. These countries, particularly China, have been found to leverage on the opportunities of megaproject investments in developing countries to hone their business model skills to enter and operate in the global market [4, 8, 31, 62].

2.1.2 *Perspectives of megaprojects in developing and developed countries*

The perspectives of megaproject investments differ between developed and developing countries [63]. While the single most important driver of mega infrastructure projects in the developing countries has been found to be the need to foster economic growth and development, the situation is different in the developed countries [29, 64-65]. The importance of concentrating megaproject investments in the developing countries is the potential to grow, for example, Africa's GDP by an additional two percent (2%) and improve productivity by about forty percent (40%) [63]. This is contrary to the situation in the developed world where such investments have been found to have a much broader focus [69].

The main motivation for megaproject investments in the developed world has been construed in terms of technological, political, economic and aesthetic motivations [10, 66]. Under the technological motivation, megaproject investment has been influenced by the excitement and satisfaction that engineers, designers and architects derive from delivering iconic and innovative projects such as the Burj Khalifa Tower in Dubai, the Channel Tunnel which links the United Kingdom to France, and the Boston's Big Dig projects [67]. The political motivation is premised on the satisfaction, attention, exposure, and visibility that politicians derive from building huge and complex monuments [54]. Although this exposure has been viewed positively, it has also been found that when the megaprojects failed, the consequences have often been catastrophic to the detriment of the reputations of the actors involved [66]. The economic motivation has been supported as the delight that business actors and trade unions derive from generating lumpy economic and financial benefits as well as job creation opportunities from mega infrastructure projects [60]. This is a reason that due to their enormous sizes, megaprojects have sufficient scope and budgets to meet the diverse aspirations of the different actors involved [49, 68]. Lastly, the aesthetic motivation has to do with the pleasure that designers and users derive from the beauty associated with iconic buildings and structures such as the Sydney Opera House and the San Francisco's Golden Gate Bridge, which are both considered as aesthetically breath-taking ventures [69]. In addition to these different motivations, some other world megaproject investments, such as Tokyo's Metropolitan Expressway, Hong Kong Airport, the Milau Viaduct in France and the Oresund Link between Sweden and Denmark, have been designed to meet other spatial and aesthetic objectives such as contributing towards urban renewal and macroeconomic efficiency [70]. Other megaproject investments serve as a direct public sector intervention to counter macro-economic depressions, as was the case in USA where projects such as highways and stadia have formed part of the government's interventions to ameliorate the impacts of the Great Depression in the 1950s and 1960s [67].

2.2 *Megaproject performance*

Despite the importance of megaprojects in economic development, a major concern remains the persistent poor performance of megaprojects [9, 27]. Studies across different sectors have highlighted that up to 82% of megaprojects fail to perform in accordance with the established performance evaluation criteria [9, 14, 32, 71]. This higher percentage of underperforming megaprojects overshadows the few that have performed well but unacknowledged. For instance, from the construction sector perspective, the Beneluxlijn metro rail project (Netherlands) has been viewed as a successfully implemented construction megaproject [11, 72]. Its construction was completed within budget and a few months after the target completion date [72]. As for the IT sector, the case of Kroger Co's successful migration from the traditional waterfall model to the agile methodology including has also been described as a successful megaproject [73]. Despite these notable cases of successful megaprojects, most similar-sized projects have performed poorly in terms of budget overruns, scope creep, schedule overruns, costly environmental impacts as well as in terms of the overall failure to achieve the original project, business and community goals [9, 32].

By and large, megaproject underperformance has occurred across different sectors and geographic spaces [39, 71, 74]. Under the construction sector, cost and schedule overruns are the most common challenges facing mega infrastructure projects [32, 75-76]. This view has been supported by findings from a study involving 52 multi-sectoral megaprojects located across the developed world, where between 73% and 77% of the projects underperformed against original cost and schedule baselines [71]. Another cross-sectoral comparative study revealed that hydroelectric and nuclear power mega infrastructure projects do experience the worst schedule and cost overruns, mainly due to the novelty of technology, perceived risks and safety issues involved [12]. A number of underperforming construction-based megaprojects have been found across Europe, the USA, Asia and Africa (Table 4).

Table 4: Examples of Megaprojects that Underperformed

Country of Location	Project Name	Performance Measurement	Literature Consulted
United Kingdom and France.	Channel Tunnel project.	<ul style="list-style-type: none"> ▪ 80% overall cost overruns. ▪ 140% financing cost escalation of original estimates. 	<ul style="list-style-type: none"> ▪ [12, 71]. ▪ [9, 50, 54].
USA.	New Denver International Airport.	<ul style="list-style-type: none"> ▪ 200% in overall cost overruns. ▪ Passenger traffic- 50% of projected. 	<ul style="list-style-type: none"> ▪ [9, 39, 50]. ▪ [9].
South Africa.	Gauteng Freeway Improvement Project.	<ul style="list-style-type: none"> ▪ Perceived negative impact of cost of living triggered community unrest and payment boycotts. 	<ul style="list-style-type: none"> ▪ [77].
South Africa.	Gautrain Rapid Rail Link.	<ul style="list-style-type: none"> ▪ 870% in overall cost overruns between 2000 and 2011. 	<ul style="list-style-type: none"> ▪ [9, 50].
Denmark and Sweden.	Scandinavian Great Belt Rail Tunnel.	<ul style="list-style-type: none"> ▪ 110% in overall cost overruns. ▪ Negative environmental impacts triggered community unrests. 	<ul style="list-style-type: none"> ▪ [9, 39].
Hong Kong.	Chek Lab Kok Airport.	<ul style="list-style-type: none"> ▪ Cost overruns negatively impacted on the country's economy by about US\$20 million. 	<ul style="list-style-type: none"> ▪ [39].
Kenya.	Mombasa-Nairobi Railway.	<ul style="list-style-type: none"> ▪ 400% budget overrun to 6% of GDP. 	<ul style="list-style-type: none"> ▪ [30].

In terms of the IT sector, one of the most extensive studies has been conducted by The Standish Group [74] in the form of periodic analysis of the performance of megaprojects from across the world since 1994. The study uses a global database of more than 50,000 projects which are categorized as “successful”, “challenged” and “impaired” [75]. Successful projects are the projects that have been delivered within budget, on time, and within the performance requirements and, as a result, are able to save at least USD40 billion per annum globally [74]. Challenged projects have been completed and operationalized but exceeded the budgets, overshot the time estimates and do offer fewer features than originally specified. These projects experience additional costs of about USD132 billion annually globally [75; 48]. Lastly, impaired projects were cancelled during their development cycle but nonetheless still incur about USD77.5 billion in additional costs annually [74]. The performance trends across the three categories of projects has been studied between 1994 and 2015 (Figure 2).

Based on the results in Figure 2, the majority of projects analysed between 1994 and 2015 have been challenged. When combined, an average of 71% of the IT projects were either challenged or impaired. Similar trends have been established in a study of ICT projects which were implemented by the Dutch government, where 13% were considered successful, 58% were challenged and 29% were failed projects [74]. Additionally, when measured against financial, schedule and expected benefit baselines, about 30% of the IT megaprojects drawn from across the world have suffered cost overruns of up to 100%, while 35% have experienced schedule slippages of up to 200% [75]. More concerning about the result, close to 40% of the projects have completely deviated from the originally specified content. In another assessment conducted by The Standish Group [74] in 2016 focusing on IT projects drawn from across the world, almost similar trends were established (Figure 3).

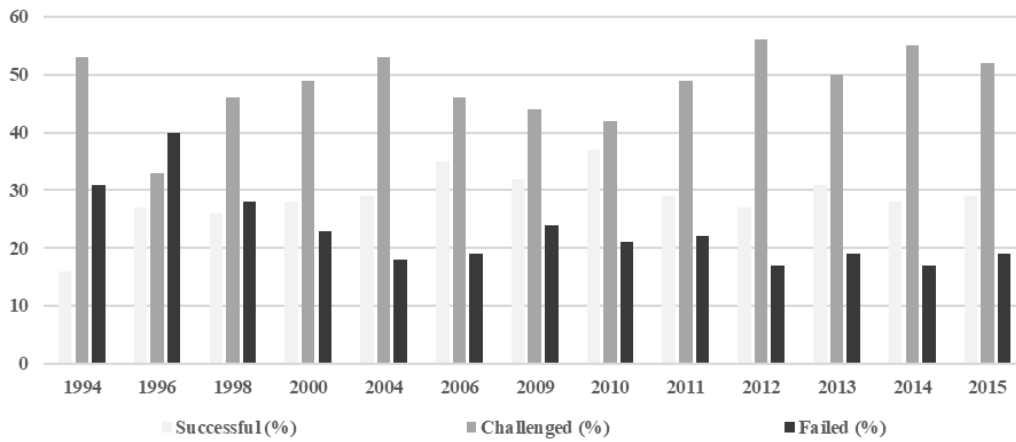


Figure 2. IT Megaproject Performance (Source [74])

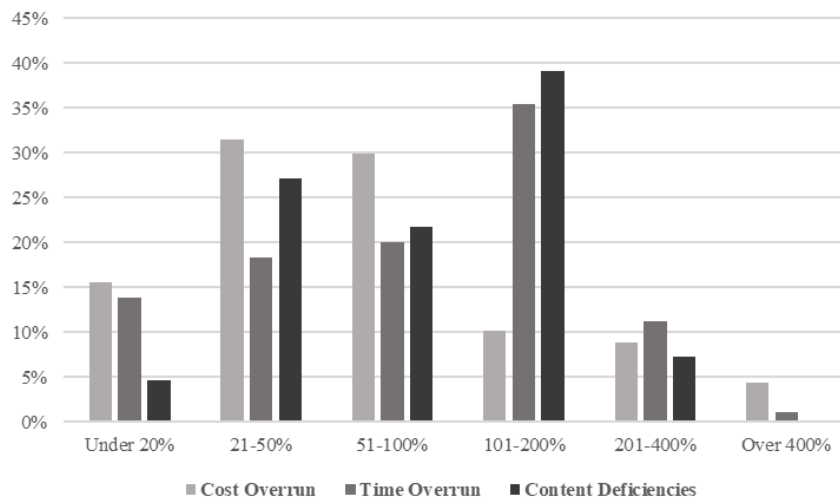


Figure 3. IT Megaprojects Underperformance (Source [74])

3. Research method

It is worth recalling that the aim of this study was to establish some of the factors that impact the performance of megaprojects and recommend suitable management processes and competences that can equip project teams to improve on the delivery of megaprojects. This study sought to achieve this aim by addressing the following objectives:

- Establishing the main factors causing the poor performance of megaprojects, based on the lessons from IT and construction megaprojects;
- Recommending suitable management processes and competences for improving megaproject performance; and
- Determining the implications of improved megaproject performance particularly for developing countries.

This investigative phase of the study forms part of the literature review stage of an ongoing research program. Consequently, the research method used is the review of existing literature on the subject matter as no primary data had been collected at this stage. This section, therefore, discusses the literature review method which has been utilized to achieve the preceding objectives. The first part of the methodology employed identified the different literature review options, which have been accentuated by different authors which include critical review, narrative review, mapping review, meta-analysis, mixed methods review, overview description, qualitative evidence analysis, rapid review, scoping review, state-of-the-art review, systematic search and review, systematized review and umbrella review [78-79]. These different methods were then assessed based on their suitability for achieving this study’s objectives. The methods retained include critical review, narrative review, integrative review and systematic review. This process was then followed by a detailed assessment of each method’s objectives, advantages and disadvantages (Table 5).

Table 5: Objectives, Advantages and Disadvantages of Literature Review Methods

Review Methods	Objectives	Advantages	Disadvantages
Critical review.	Aims to demonstrate that the writer has extensively researched the literature and critically evaluated its quality.	A critical review provides an opportunity to ‘take stock’ and evaluate what is of value from the previous body of work.	Critical reviews do not typically demonstrate the systematicity of other more structured approaches to the literature.
Narrative review.	Provides a systematic process for identifying and selecting materials, synthesizing them in textual, tabular or graphical form, and for making some analysis of their contribution or value.	Identifies what has been accomplished previously to allow for consolidation, summation, avoiding duplication and identifying omissions or gaps.	Lacks an explicit intent to maximize scope or analyse collected data and hence its conclusions may be open to bias from potential omissions of literature sections or not questioning the validity of statements made.
Integrative review.	Focuses on reviewing, critiquing, and synthesizing representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated.	Ability to deal with dynamic complex topics with potential to generate contradictions. Provides review and critique to resolve inconsistencies in the literature.	Potential challenges for researchers to fail to maintain scientific integrity and associated threats to validity due to too narrow definition of constructs.
Systematic review.	Considered as the best-known type of review, which seeks to systematically search for, appraise and synthesis research evidence in a way that is transparent and replicable by other researchers.	Upheld for ability to draw together all known knowledge on a topic area.	Restricting studies for inclusion to a single study design such as randomized controlled trials can limit the application of this methodology to providing insights about effectiveness rather than seeking answers to more complex search questions.

This analytical process resulted in the selection of the integrative literature review as the most suitable research method for addressing the objectives of this study. The decision was also informed by the method’s comprehensiveness in reviewing, critiquing and synthesizing literature pertaining to the study constructs [79-81]. The integrative literature review method has been advanced as a suitable method for reviewing dynamic topics which are perceived as experiencing rapid growth but have not benefited from a wide and comprehensive review and update over an extended period [82]. Integrative literature reviews have also been recommended when dealing with new and emerging topics whose complexity have the potential to generate a contradiction or discrepancy between what is found in literature and what is observed about the issue [79]. It was on the basis of these different attributes, that the integrative review method has been adopted under this study and used to analyse existing literature on IT and construction megaprojects towards addressing the research objectives in the discussions preceding this section on the research method.

The approach involved the critiquing, synthesizing and reconceptualizing of findings drawn from existing literature on megaproject attributes and their performance implications as well as suitable project management processes and competences for improving megaproject delivery. Special attention was given to literature that focused on IT and construction megaprojects.

The integrative literature review process involved four key stages. Firstly, the relevant journal articles that dealt with megaprojects in general were selected using the Social Science Citation Index as well as the Web of Science [81]. Secondly, journal articles which focused on IT and construction megaproject attributes including their performance implications and suitable project management processes and competences were selected, regardless of their year of publication. Thirdly, out of these journal publications, the articles published between the years 2012 and 2019 were prioritized, although a few older ones were also reviewed for trend analysis of the megaproject attributes and their performance implications as well as suitable project management processes and competences (Table 6). Lastly, the trend analysis provided the opportunity of establishing the critical gaps and in drawing specific conclusions relevant to the study’s objectives. The research’s objectives and the theoretical framework were the lenses through which the various articles were selected and reviewed.

Table 6: Summary of Literature Review Methodology Flow

Theoretical Framework	Relevant Literature Selection	Core Constructs	Integrative Literature Review Processes	Key Outputs
Complex Adaptive Systems Theory.	Journal Articles published between 2012 and 2018. Limited number of journal articles older than 2012. Limited number of other non-journal articles and books.	Megaprojects attributes and performance implications. Required management processes and competences. Implications of improved megaproject performance in developing countries.	Critical Analysis. Synthesizing. Reconceptualization.	Trends across constructs. Key conclusions.

4. Study findings

This section discusses the findings of the study objectives. Firstly, the key attributes of megaprojects and the factors that influence their performance are explored. This was followed by a comparative assessment of these characteristics and performance factors within the context of IT and construction megaprojects. The purpose of this comparative assessment was to create the necessary distinction and draw important lessons required to guide the subsequent discussions. Based on the outcome of this assessment, the study recommended some of the suitable project management competences and processes that can better equip project management teams to deal with megaproject complexity attributes and improve performance. Lastly, the implications of these performance improvement mechanisms on project management in general, and developing countries, in particular, are then analysed.

4.1 Characteristics of megaprojects

Mega infrastructure projects exude certain characteristics which distinguish them from the other conventional projects [20, 24]. Some authors have attributed the difficulties associated with delivering mega infrastructure projects and, ultimately, their poor performance, to these properties [9, 20, 83]. Consequently, it has been cautioned that mega infrastructure projects should not be perceived as magnified versions of smaller projects, but rather, as completely different ventures in terms of scale, objectives, structural and institutional complexity [33]. This view has been justified, particularly, by the extent and nature of the complexity attributes involved in delivering these gigantic ventures [16, 84]. Some of these unique distinguishing characteristics have been found common across IT and construction megaprojects (Table 7). These findings act as an important basis for drawing important lessons which can be applied to other similar projects in order to contribute towards improving performance.

Table 7: Megaproject Characteristics

Megaproject Characteristics	References for Prevalence under Construction Megaprojects				References for Prevalence under IT Megaprojects			
	[9]	[27]	[39]	[54]	[2]	[23]	[50]	[72]
Extensive physical size.	✓	✓	✓	✓	✓		✓	✓
Huge budgets.	✓	✓	✓	✓		✓	✓	✓
Long planning and implementation timeframes.	✓	✓	✓	✓	✓	✓		
High media attention.		✓						
High social and political significance.		✓	✓					
Involvement of multi-disciplinary and often virtual professional teams.	✓	✓	✓	✓	✓	✓	✓	✓
Complex activity interdependences.	✓	✓	✓	✓	✓	✓	✓	✓
High pace and require innovative approaches.	✓		✓	✓			✓	✓
Complex iterative decision-making processes.	✓	✓	✓	✓	✓	✓	✓	✓
Diverse stakeholders.	✓	✓	✓	✓	✓	✓	✓	✓
High risk and uncertainty from technological novelty.	✓	✓	✓	✓	✓	✓	✓	✓
Complex contractual frameworks and procurement processes.	✓	✓	✓	✓	✓	✓		

4.2 Megaproject performance

This section discusses the attributes that influence megaproject performance. It started off with the debates around the different criteria used to assess megaproject performance. The debates were then followed by a comparative assessment of the performance factors to determine their applicability to IT and construction megaprojects. The eventual findings were then used to highlight some of the gaps in the current project management approaches as the bases for identifying and recommending the suitable management processes and competences that can be applied to improve megaproject performance.

4.2.1 Megaproject performance measurement criteria

While project performance has been studied for a long time, there has been no universally accepted measurement criteria or what constitutes project success [84]. Different studies have come up with an inexhaustible list of measurement metrics, which has resulted in some inconsistencies in the conclusions that have been drawn [77, 85]. Different models have also been proffered in an attempt to delineate suitable performance measurements criteria [87, 86]. For instance, some authors have suggested the need to distinguish between project management success and project success as a way of minimizing the ambiguities involved [53, 84, 86]. Consequently, project management success has been construed as covering the tripartite project management elements of time, cost and quality while project success focuses on the broader aspects of a project beyond the tripartite constraints or golden triangle [84].

Under project success, some authors suggested that other important factors such as the priorities of different stakeholders, contextual factors, the projects' financial and non-financial impacts on the organisational value, and the associated time dimensions must form part of the performance evaluation criterion [85]. These broader evaluation criteria have been advanced as a way of ameliorating against some of the gaps associated with the traditional performance assessment methods centred only around the triple constraint factors of time, cost and quality [86]. This view has been underpinned by findings from cases where, despite having exceeded the planned time and budgets, some projects were still considered to have been very successful, while in other cases those that would have been completed on time and within budgets still failed to satisfy the needs of investors [53]. Consequently, the need to incorporate more attributes beyond time, cost and quality resulted in a further differentiation of project performance into project and product success [84, 86]. While on the one hand, product success is a measure of the extent to which the project would have met the customer's organizational or business goals, project success, on the other hand, is an absolute measure of how the project would have achieved the traditional triple constraint success criteria [84-85]. As discussed earlier, an example which has been used to demonstrate product success is the migration by The Kroger Co from traditional waterfall to agile processes, where the associated benefits were accentuated in the form of achievement of the

company’s financial and non-financial goals as well as client satisfaction metrics [73]. Based on these performance measurement dynamics, this study proposed an evaluation model which incorporates financial and non-financial measures including the broader customer, community, environmental and political aspects (Figure 4).

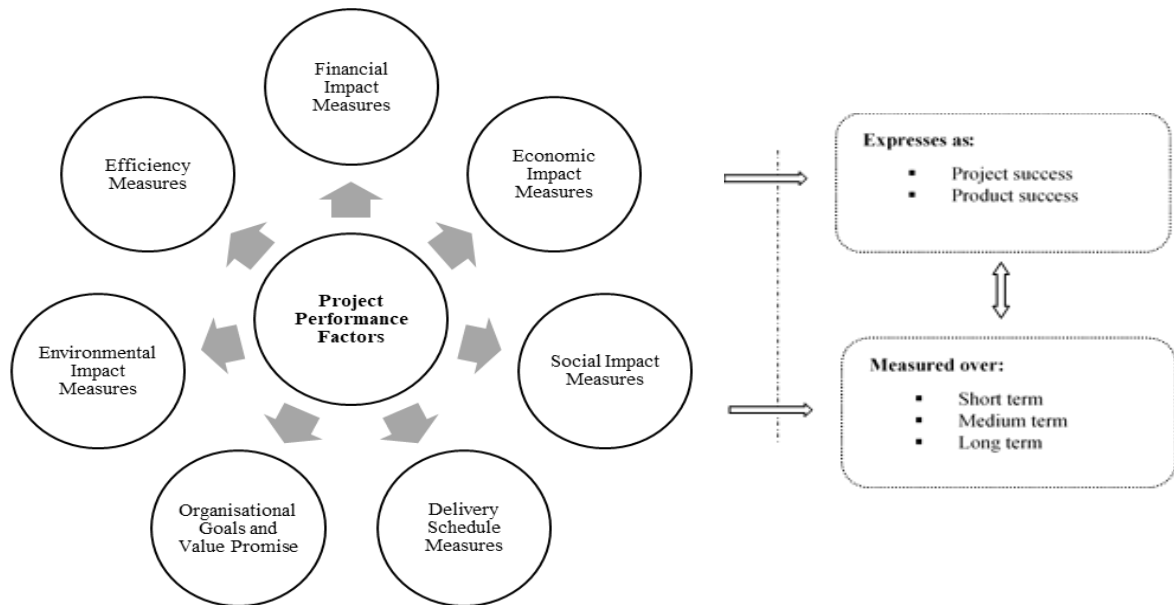


Figure 4: Proposed Performance Measurement Model

4.2.2 Megaproject performance factors

The poor performance of megaprojects has been attributed to a variety of factors which, most notably, include inaccurate forecasting and cost estimations, wrong planning and implementation strategies, underestimation of potential delays, inadequate risk management, unanticipated scope creep, unforeseen geological and environmental challenges, technological factors, poor project governance and stakeholder management, and human resource problems [87]. Some authors have also posited that these factors should be further delineated in accordance with the megaproject delivery stages in order to trace where, in the project cycle, failure would have taken place and, consequently, inform the designing and targeting of suitable intervention measures and improvement processes [37, 88]. Megaproject performance can also be explored from the technical (economic and technological) and human (psychological and political) perspectives [26, 89-90]. Lastly, another comprehensive categorization of performance factors has been based on location and technology, team organization and communication, planning and execution processes, governance and stakeholders, and the delivery strategy [91-92]. Due to the comprehensiveness of this preceding categorization, it has been adopted in the comparative assessment of IT and construction megaproject (Table 8).

What becomes clearer in the list of performance factors is the disproportionate share of human attributes. As a result, based on the Pareto principles, some authors have posed that human factors account for over eighty percent (80%) of megaproject failures [77, 90]. For instance, in a study of about 214 IT projects which were drawn from across the world, it was found that about twenty four percent (24%) were cancelled. Out of these cancelled projects it was found that fifty three percent (53%) of the cases had to do with management-related issues, twenty seven percent (27%) were due to technology-related issues, while twenty percent (20%) were a result of business/organization-related issues [9]. It then follows that the predominance of human factors in influencing megaproject performance has been used as a point of reference in highlighting some of the gaps associated with traditional project management approaches and methods

[72, 80]. This point of reference is further justified by the debates around subjects such as megaproject performance measurement criteria [84-86].

Table 8: Megaproject Performance Factors

Megaproject Performance Factors	Applicability to Construction Megaprojects		Applicability to IT Megaprojects	
	[12]	[92]	[75]	[77]
Location and technology	-Unavailability of qualified craft workers. -Logistical challenges e.g. non-existing infrastructure, logistics and transportation needs. -Complicated political and regulatory environment and local content requirements.			Shortage of skills/ competences.
Team organization and communication	-Inappropriate project organizational structure. -Lack of coherent teams, high turnover of experienced and skilled staff, and frequent changes in project leadership. -Lack of team and cultural cohesion regarding language, beliefs and working styles due to geographically dispersed who are unfamiliar and working together for the first time.	Management and leadership factors. Team skills and competences.	-Lack of executive management support. -Unrealistic expectations.	-Team members lack skills and competences. -Overambitious plans. - Poor leadership in project delivery. -Critical skill shortages -Insufficient management support.
Planning and execution processes	-Optimism bias and strategic misrepresentation. -Inadequate and non-comprehensive risk assessment, mitigation and management. -Lack of execution plan alignment and insufficiently integrated schedule. -Regulatory and environmental delays. -Baseline schedule acceleration and compromised schedule quality. -Ineffective change management. -Unfit documents, procedures and processes.	Overambitious project size. Complexity attributes.	-Unmanageable project size. -Unmanageable complexity levels. -Unclear statement of requirements. -Poor planning.	-Project oversizing, long delivery schedules and poor estimation methods. -Project volatility, complexity and black swan effects. -Poorly defined technical requirements, inappropriate technical designs and poor risk management. -Inappropriate user documentation and development tools.
Governance and stakeholder management processes	-Involvement of joint ventures among project owners, funders, consultants and contractors. -Convolutated governance processes with poorly defined roles and responsibilities. -Complexity contractual framework. -Multiple stakeholders and coordination challenges and cross functional group interfaces. -Poorly designed project contracting and delivery strategies.		Poor user involvement.	-Poor stakeholder communication. -Poor stakeholder management.
Delivery strategy	-Unclear and ambiguous contracts. -Difficult collaboration among owners, funders, consultants, contractors and suppliers. -Complex local content requirements regarding the procurement of material suppliers and contractors.			

One of the main gaps has been ascribed to the limitations associated with the traditional project management methods in addressing the complexities emanating from the interaction of the different megaproject characteristics [36, 93]. Consequently, complexity has been highlighted as the single most impactful megaproject performance factor [5, 36]. It has been posited that megaproject complexity tends to increase in proportion to the size of the project [3,16]. Moreover, it has also been proven that the size, duration and complexity of mega infrastructure projects makes them unmanageable in terms of accurately predicting critical interdependencies and relationships, emergent and unpredictable human behaviours as well as the constantly evolving internal and external environments [3]. Based on the output of a size-complexity matrix [74], the other related models such as the Contextual IT Project Framework [36], and the

Complexity-Leadership Model [34], this study encourages project management teams to carefully plan and appropriately scale the size of their projects in order to contain the magnitude of complexity involved and, ultimately, improve their chances of success. In order to illuminate the complexity attributes associated with megaprojects, Complexity Theory has, generally, been adopted as a suitable lens due to its universal application across multiple disciplines such as biology, physics, chemistry, mathematics, science, meteorology, and social sciences [62]. However, it has also been countered that there is no unified theory of complexity, but rather, related concepts and theories such as catastrophe, chaos, dissipative structures, multi-agent systems, and systems theory [9, 33, 35].

One branch of Complexity Theory, whose application in megaprojects has been reasonably researched is the Complex Adaptive Systems (CAS) Theory [33, 62, 93]. By drawing insights from the findings of such CAS-based research, this study has also adopted the CAS Theory as a suitable lens in assessing the complexity attributes involved in megaproject delivery. By definition, CAS has been construed as a system that is adaptive, based on the emergent properties that arise from the system’s interaction with its internal and external environments [16]. The main properties of CAS include co-evolution, emergence, self-organization, fitness landscape, edge of chaos, dynamism, non-linearity, and adaptation [33, 62, 93]. Within the context of construction megaprojects, the CAS Theory has been found applicable at the levels of the industry, project management office, project site, and project management team [51, 95]. The different CAS attributes have also been found to have been applicable in megaprojects (Table 9).

Table 9: Applicability of CAS Attributes to Megaprojects

CAS Attribute	Mega Infrastructure Project Characteristics	Consulted Literature Sources
Multiple agents.	Multiple stakeholders including owners or sponsors, funders, regulatory entities, project management consultants, specialist consultants, contractors, subcontractors, material suppliers, unions, watch dogs and user groups.	[12, 33, 35, 62, 93].
Hierarchical structure.	Organizational and decision-making structures consisting of the owner or sponsor, funders, managers, consultants, contractors and material suppliers.	[12, 16, 26, 33, 42, 62].
Modular structure.	Mega infrastructure projects modules consist of sub-projects as well as planning (concept design, prefeasibility study, feasibility study), financing (financing and detail design) and implementation (tendering, construction and operation) stages.	[42, 93, 70, 72, 90].
Adaptive capacity.	Use of innovative contracting methods and various forms of partnerships to expedite decision making and conflict resolution.	[89, 90].
Co-evolution and Self-organization.	Evolution in response to stakeholder requirements, financial need, limited capacity, etc. Uniqueness due to factors such as quality of front-end planning, specifications, clarity of goals, completeness of implementation programs, etc.	[86].
Emergence.	Formation of alliances, partnerships, coalitions, policies, protocols locally, regionally and internationally.	[26, 34].
Dynamism and non-linearity.	Multiple sub-projects which are delivered by separate but inter-dependent specialist teams and exhibit processes and cultures which are different from those of the global project.	[77, 96].

The findings from these studies have been used as the basis for the selection of the CAS Theory as the most suitable framework under this study. Ultimately, this study uses the CAS Theory principles to delineate the most suitable complexity management competences and processes.

4.3 Complexity management processes and competences

The application of the CAS Theory to megaproject characteristics and delivery has been used to highlight some of the gaps associated with traditional project management processes and approaches [5, 34, 76]. For instance, it has been established that traditional project management competences do not adequately equip project management teams to deal with the complexity attributes involved in delivering megaprojects [92, 96]. This view has been corroborated by equating the competences and processes required to deliver megaprojects to a jumbo jet pilot’s license [10]. By implication, trying to deliver a megaproject using traditional management competences and processes can be likened to attempting to fly a jumbo jet using a motor vehicle driver's license and, hence, the widely reported failures.

Consequently, a new set of unique management processes and competences has been propounded to further equip project management teams to effectively deal with the complexity attributes involved in delivering megaprojects and improve their performance [68, 92, 96]. These unique management processes and competences have been informed by, and structured around, the different CAS properties associated with megaproject delivery such as leadership, positive behaviour and success mentality, flexibility and adaptability, and organizational structure (Table 10).

Table 10: Competences and Processes for Managing Megaprojects as CAS

Management Processes	Consulted Literature	Management Competences	Consulted Literature
Processes that emphasize leadership approaches more than techniques of control and power.	[92].	Ability to create an engaging ecosystem for stakeholder engagement, adaptive concept scoping and human engineering.	[9, 86].
Processes that propagate positive behaviour and success mentality e.g. unique incentives and inhibitions.	[53].	Creating an enabling environment for innovation through space for creativity, engagement, debate and co-creation.	[5, 6, 96].
Processes that emphasize the assessment of the value of outcomes rather than efficiency optimization.	[97-98].	Architecting complex change through diffused leadership, agile project processes, etc.	[90].
Processes that leverage and encourage adaptive and learning attributes than enforcing of optimization-focused systems, contracts and processes.	[11].	Building a performance culture by e.g. structuring of contracts around shared accountability, mutual achievement and collaborative partnerships.	[6, 89].
Processes that emphasize incentives and encourage personal commitments e.g. transparent organizational practices, policies and outcomes.	[13, 62, 89].	Aligning business models through deliberate migration from strict compliance to contracts towards using human collaboration.	[23, 89].
Models that shift decision making from centralized command and control to points of interface in the mega infrastructure project structure.	[5, 68, 77, 89].	Changing leaders through distributed leadership models which shifts focus from managing complicated technological projects to leading complex social interactions.	[5, 92, 95-96].
Organizational structure and processes which are flexible enough to adapt as more knowledge is gained in the system.	[68, 23].	Learning agility through moving away from risk averse governance to embedded learning models.	[96].

4.4 Implications of complexity management processes and competences

The comparative assessment of the characteristics and performance attributes of IT and construction megaprojects revealed some similarities which can be generalized across other similar projects. For instance, the disproportionate role played by human factors in influencing the success of megaproject delivery posed questions regarding the adequacy of the project management approaches currently used in delivering these projects. As such, given the similarities that have been found across the IT and construction megaprojects, it can be advanced that the management competences and processes are applicable to megaprojects across different sectors. This has implications for the project management field as now discussed next. Most of these management processes are outside the traditional project management philosophy as they have been largely informed from a megaproject complexity perspective. Consequently, these competences and processes can complement the skills, approaches, and processes of the current traditional project management discipline and, by extension, enhance the project management teams’ capabilities in delivering megaprojects.

Furthermore, the inclusion of these competences and processes in the project management curriculum can contribute towards equipping future project managers to effectively deal with megaproject complexity attributes and to achieve better performance. This is, particularly, important in the developing countries where there has been a general dearth in the capacity of project teams to effectively deliver megaprojects. A case in point has been the infamous Kusile and Medupi Power Stations in South Africa, in both of which an overreliance on foreign experts has not augured well both

in the delivery and performance of the power station [6, 8]. Additionally, the rapid proliferation of megaprojects in developing countries and the potentially disastrous consequences of their failure further underscore the importance of these competences and processes in contributing towards performance improvements. Given the huge cost of megaprojects relative to the developing countries' GDP, any mechanisms that can result in performance improvements will have substantial positive socio-economic impacts. Based on these implications, this paper has managed to achieve its stated objectives.

5. Conclusion

This paper aimed to illuminate some of the main factors behind the poor performance of megaprojects to establish the required improvement mechanisms. This has been achieved by analysing some of the main characteristics which make megaprojects complex to manage and highlighting some of the key factors that influence their performance. This was achieved through a comparative review of findings from literature on IT and construction megaprojects. The main megaproject characteristics from the two sectors and the associated factors that influence their performance were analysed and found to be relatively similar. The paper then crystallized how some of the gaps associated with the traditional project management practice limit the capabilities of the project management teams to effectively deal with the complexities involved in megaproject delivery. By applying of the CAS Theory, the important management processes and competences for megaprojects were then identified as some of the mechanisms that can be used to equip project management teams to deliver megaprojects more effectively. Justifications were given on how the proposed processes and competences can improve the performance of megaprojects and positively impact the economies, particularly of developing countries. Most importantly, the in-depth review and comparative analysis of megaprojects in the IT and construction sectors has brought to the fore the inherent complexities associated with megaprojects. A limitation of this paper has to do with the unavailability of empirical data to back and test some of the propositions; thus, setting the background for further investigation in the future. Having said, the findings from this study contribute to the project management body of knowledge by setting the stage for discussions on linking the proposed management processes and competences to specific megaproject complexity attributes. This is a knowledge gap that has been identified and which serves as one of the focus areas under an ongoing broader research program.

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