# ONLINE APPENDIX

## "Decision Considerations Influencing Information Systems Modularity: A Multimethod Study of LEGO"

**Stefan Henningsson, Ben Eaton, Lorenz Törmer & Suprateek Sarker**

## Appendix 1. Research on information systems modularity

**Table A1.1.** Research on information systems modularity

| Construct | Role of modularity | Outcome(s) of interest and findings |
|---|---|---|
| IT infrastructure flexibility | Modularity enables reconfiguration (i.e., add, modify, or remove) and reuse of IT components with ease and without any major overall effects. | IT infrastructure flexibility enables organizational responsiveness and competitive advantage (Bhatt et al., 2010)<br><br>IT infrastructure flexibility supports a firm's dynamic capabilities and firm performance (Kim et al., 2011)<br><br>IT infrastructure flexibility increases the value created from mergers and acquisitions (Benitez et al., 2018)<br><br>IT infrastructure flexibility enhances firm performance by strengthening supply chain responsiveness (Bush et al., 2010) |
| IT flexibility | Modularity contributes to that IT resources can be decomposed and recombined to support new purposes. | IT flexibility increases the value created from mergers and acquisitions alliances (Bush et al., 2010; Tafti et al., 2013)<br><br>IT flexibility positively influences organizational performance (Wagner et al., 2014)<br><br>IT flexibility is necessary, but have to be balanced with the need for IT efficiency (Widjaja & Gregory, 2020) |
| IT architecture flexibility | Modularity facilitates flexibility in configuring systems. | IT architecture flexibility enables IT dynamic capabilities which positively impacts competitive performance (Mikalef et al., 2020) |
| IT agility | Modularity decreases the need for coordination among organizational subunits. | IT agility positively influence IT alignment and firm performance (Sambamurthy et al., 2003; Tallon, 2007; Tallon & Pinsonneault, 2011; Tiwana, 2013; Tiwana et al., 2010) |
| Systems evolvability | Modularity contributes to systems' capacity to efficiently change to serve new purposes. | Systems evolvability allows organizations to adapt to environmental changes and ultimately preordain the survival of organizations (Agarwal & Tiwana, 2015) |
| IT-enabled flexibility | Modularity enhances business flexibility and adaptation to marketplace changes. | IT-enabled flexibility helps firms overcome internationalization risk and compete globally (Khuntia et al., 2019) |

## Appendix 2. Data collection

**Table A2.1.** Record of interviews and interviewees

| Interview Phase | Date | Interviewee | Length (hh:mm) |
|---|---|---|---|
| Exploration of LEGO's approach to IS architecture | 13.07.2017 | Senior EA (1) | 01:23 |
| | 01.09.2017 | Head of EA | 00:45 |
| | 06.09.2017 | Head of Technology & Security | 00:54 |
| | 06.09.2017 | VP for Engagement Technologies and Analytics | 00:27 |
| | 07.09.2017 | Principal EA | 01:14 |
| | 03.10.2017 | Head of EA | 01:10 |
| | 16.11.2018 | Principal EA | 01:15 |
| | 17.09.2018 | Senior Solution Architect (2) | 00:37 |
| | 15.11.2018 | Head of EA | 00:56 |
| | 10.12.2018 | Senior Solution Architect (1) | Not recorded. 60 mins |
| | 04.07.2019 | Chief Information Officer (CIO) | 01:18 |
| | 30.01.2020 | Head of Digital Transformation | 00:33 |
| | 27.10.2017 | Principal EA | 01:13 |
| | 08.03.2018 | Senior Solution Architect (2) | 01:04 |
| | 19.04.2018 | EA Director (3) | 01:11 |
| | 23.04.2018 | Principal EA | 01:05 |
| | 23.04.2018 | Senior Solution Architect (5) | Not recorded. 60 mins |
| | 24.04.2018 | Director for Consumer Marketing Platforms | 47:07 |
| | 24.04.2018 | Head of Big Data Platform Engineering | 00:34 |
| | 10.12.2018 | Senior EA (2) | 00:42 |
| | 05.07.2019 | EA Director (2) | 00:46 |
| | 09.07.2019 | Senior EA (2) | 00:52 |
| | 16.10.2019 | Director for Integration and Database | 00:52 |
| | 30.01.2020 | EA Director (2) | 00:35 |
| | 30.01.2020 | EA Director (3) | 00:37 |
| | 01.07.2019 | Senior Solution Architect (1) | 00:51 |
| | 09.07.2019 | Principal EA | 01:02 |
| | 25.07.2019 | EA Director (3) | 59:26 |
| | 06.08.2019 | VP for Manufacturing and Supply Chain Technologies | 57:45 |
| | 26.08.2019 | Program Director for Strategy and Transformation | 00:50 |
| | 03.04.2019 | EA Director (3) | 00:54 |
| | 03.04.2019 | Senior EA (1) | 00:44 |
| | 15.07.2019 | VP, Finance Business Partner for COO | 01:17 |
| | 30.01.2020 | Senior EA (1) | 00:28 |
| Individual Points of Architecting | 31.10.2019 | EA Director (3) | 00:26 |
| | 04.11.2019 | Senior Solution Architect (1) | 00:29 |
| | 06.11.2019 | EA Director (4) | 00:24 |
| | 06.11.2019 | Senior Solution Architect (5) | 00:25 |
| | 06.11.2019 | Senior Solution Architect (6) | Not recorded. 60 mins |
| | 01.11.2019 | Senior Solution Architect (6) | Not recorded. 30 mins |
| | 14.11.2019 | EA Director (4) | 00:47 |
| | 14.11.2019 | Principal EA | 01:19 |
| | 15.11.2019 | Senior Solution Architect (7) | 00:20 |
| | 18.11.2019 | Product Owner | 00:27 |
| | 18.11.2019 | Senior Solution Architect (5) | 00:23 |
| | 19.11.2019 | Senior Solution Architect (4) | 00:21 |
| | 21.11.2019 | Director Product Owner for Maintenance | 00:49 |
| | 22.11.2019 | Director for Technology Incubation | 00:32 |
| | 25.11.2019 | Senior IT Consultant | 00:23 |
| | 25.11.2019 | EA Director (5) | 00:55 |
| | 28.11.2019 | EA Director (5) | 00:41 |
| | 28.11.2019 | Senior Solution Architect (1) | Not recorded. 60 mins |
| | 29.11.2019 | EA Director (3) | 00:29 |
| | 29.11.2019 | Senior Solution Architect (3) | 00:34 |
| | 29.11.2019 | Senior Solution Architect (3) | 00:54 |
| | 03.12.2019 | Senior Product Manager | 00:26 |
| | 03.12.2019 | Application Architect | 00:23 |
| | 03.12.2019 | Senior Solution Architect (4) | 00:18 |
| | 03.12.2019 | EA Director (3) | 00:30 |
| | 03.12.2019 | Senior Solution Architect (4) | 00:18 |
| | 04.12.2019 | EA Director (5) | 00:33 |
| | 06.12.2019 | EA Director (2) | 00:28 |
| | 06.12.2019 | Head of Big Data Platform Engineering | 00:33 |
| | 09.12.2019 | Senior IT Consultant | 00:38 |
| | 18.06.2020 | EA Director (5) | 00:27 |

## Appendix 3. Details on method, coding and analysis

Data analysis generally followed established guidance related to inductive interpretive research (e.g., Sarker et al., 2013; Walsham, 2006). Overall, when coding the data, we used paragraph-level coding of interviews on each case to identify outcome variables and contextual variables (Corbin & Strauss, 1990; Greckhamer et al., 2018). Two researchers coded the data in collaboration, resolving any disagreements through discussion (Saldana, 2009).

We coded and analyzed data in two phases. First, an inductive analysis using open coding that progressed iteratively in line with the hermeneutic circle. The inductive analysis aimed at creating a general understanding of LEGOs approach to IS architecture decisions, including decisions on IS modularity. This analysis was directed towards the first set of 34 broad interviews and observation data. This analysis revealed the two different forms of modularity considered in LEGOs approach and a set of contextual conditions that seemingly interacted to motivate selection of the different decision-alternatives. The identification of the two forms of modularity and the set of influencing conditions were carried over to the second phase.

The second analytical phase was directed, based on the framework for configurational analysis which incorporate purposive action theory, into the explanatory frame. This analysis focused on the second set of 36 follow-up interviews, specifically concerning the 31 PoAs. and was complemented with observation data and contextual understanding to interpret interview data. This coding addressed outcomes (decision alternatives), conditions (organization and situated level) and causal mechanisms (decision rationales) in each PoA.

The logical progression of these two analyses is presented graphically in Figure A3.1. This graphical overview makes one important simplification. The identification of candidate conditions in the inductive analysis and the scoping of conditions involved a gradual transition and interdependence between tasks. The inductive analysis identified candidate conditions, which were abstracted and placed in a theoretical context in the scope of conditions for the QCA. In line with QCA ambitions for a theoretically relevant and parsimonious explanation free from contradictions, the tasks of defining thresholds and assigning values to variables was an iterative activity, that required moving back and forth between data and construct definitions. To make the findings of the paper conceivable to the reader, we simplify the presentations of conditions in the paper by presenting only the final conditions included in the QCA even though they took their final shape late in the analytical process as we were operationalizing the QCA. We also only present the final assignment of PoA to conditions, outcomes and configurations although recognizing that this process was iterative with empirical and theoretical induced adjustments to reflect interpretation and to present a parsimonious explanation of findings. We further note that while not a guiding principle for the inductive analysis, the identification of two forms of modularity corresponds to a task in QCA that requires considering qualitative differences within variables and when needed make differentiations that adequately capture such differences (Furnari et al., 2020).

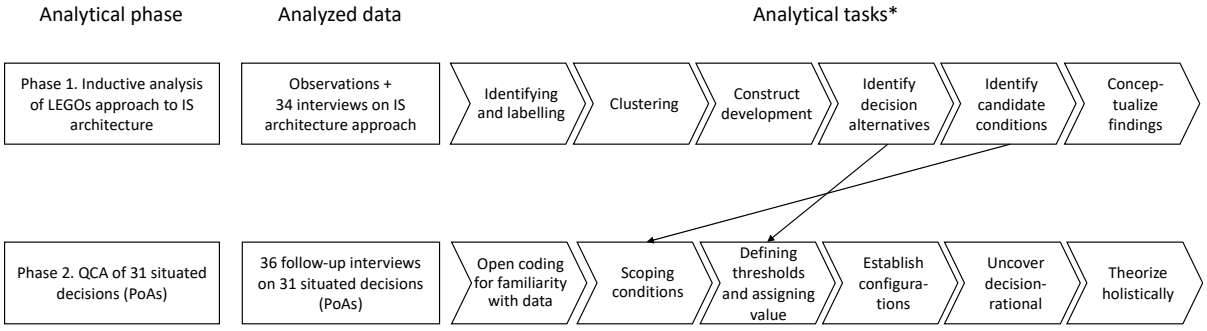



**Figure A3.1.** Logical progression in the two analyses

The guiding methodological principles motivating the inductive analysis is presented in Table A3.1. Additional details and exemplification are provided in Table A3.2. The methodological considerations for the second phase QCA are presented in Table A3.3. Figure A3.2 and A3.3 presents the analytical progression in the identification and application of decision alternatives and conditions, respectively.

**Table A3.1.** Phase 1 methodological guidelines with illustrations[4]

| Aspect of study | Methodological considerations | Additional Description | Illustrative example |
|---|---|---|---|
| Choice of focus and organizations | Selecting suitable focus and organizations to study intensively | LEGO selected as an *exemplary case* organization based on a pre-understanding of its transformative journey (Patton, 2002). | LEGO was considered an industry leader undergoing a transformation of its approach to IS architecture decisions. |
| | Entering the field with credibility | The research team had official permission from the CEO, CIO, and other key stakeholders.<br>The university of the three authors had significant name recognition and goodwill in the company. There was also a positive history of research engagement with the company. Being researchers from a well-known university, we were not seen as agents of management. | One of the researchers was invited to be immersed in the company for three years, spending several days per week as a participant observer.<br>Many high-ranking personnel in the company gladly and repeatedly gave their time. Most of them answered questions with frankness due to the trust created. |
| Data collection | Diary construction | 36 months of participant observation data and relevant supporting documents captured in a research diary to document LEGO architectural transformation (Naur, 1983) | 113 diary entries that summarize direct observations, reflections on observations, plans for future research, and supporting diagrams |
| | Choice of interviewees for inductive analysis | Key informants were deliberately selected from all relevant hierarchy levels and roles in the organization | Interviewees included CIO, Vice Presidents as well as Directors from IT, Enterprise, Solution and Application Architects |
| | Conducting the interviews | We conducted the interviews primarily at the LEGOs headquarters in Denmark. Interviews were semi-structured, typically aimed to provide details and reflections complementing observations. | For the inductive analysis, we conducted 34 interviews. With few exceptions, interviews were recorded and transcribed. |
| | Researcher involvement in the study | Data collection process involved deep engagement of one author in the case organization, balanced with a neutral perspective as a reflexive academic investigator (Walsham, 2006) | One researcher in the author team was immersed in the research context for 36 months. Weekly elaboration of research diary, critical reflection, and discussion of experiences with co-authors, enabled taking an in-depth yet detached perspective on phenomena |
| | Maintaining empathetic neutrality | Architectural decision were treated as neutrally serving different purposes rather than simply good or bad (Henfridsson & Yoo, 2014) | Modularity treated as a neutral concept rather than necessarily good or bad for the architecture or the organization |
| Data analysis | Refining our understanding of events and concepts through constant comparison | We followed Klein and Myers' principle of the *hermeneutic circle* (Klein & Myers, 1999) leading to a gradual evolution of understanding about various aspects of the phenomenon of interest. | We iteratively grew and understanding of the salient considerations in LEGO's approach to decisions, including the fundamental distinction between two forms of modularity. |
| | Triangulating data | We confirmed (or disconfirmed) the important facts or explanations across multiple sources. | We would often ask multiple respondents from different stakeholder groups, about their perspectives on an issue. For example, we examined the adherence to official approaches by participating in meetings, interviewing several stakeholder groups and inspecting documents. We also used documents to verify the occurrence and timing of events reported in interviews.<br>*Convergence of views was helpful, but divergence was also embraced* as an opportunity to investigate further, in line with theoretical sampling and the constant comparison approach. |
| | Being suspicious about evidence | We tried to be sensitive to possible *biases in interviews* and to be *suspicious* in accordance with Klein and Myers' principle of suspicion. | For example, *not accepting the straightforward, rational explanation by some high-level managers that local business managers did not care about IS architecture,* we instead investigated the causes why architecture were not always a priority in decisions and in that way identified additional considerations at play. |
| | Being sensitive to ethical concerns | We sought to balance anonymity with disclosure (Walsham, 2006). While generally not perceived as a sensitive topic, some employees and junior managers were in exposed positions that needed considerations. | We tried to *make justice to the trust placed in us* by inviting us to observe in the daily practice by treating any personal or sensitive information that could expose informants' confidentially with great care, while at the same time, disclosing information of relevance for the explanation of decision considerations.<br>At times, interviewees have asked our conversations not be recorded to be able to speak unconstrained about their views, that we have respected. However, importantly, we have *not committed to or been* |

| | | | |
|---|---|---|---|
| | | | *asked to write a positive case study* for the company. Nor has the company asked that its name be disguised. |

**Table A3.2.** Additional details for Phase 1 inductive analysis

| **Analytical tasks** | **Guiding principles** | **Implementation and illustration (when relevant)** |
|---|---|---|
| Identifying and labelling occurrences of interest | Paragraph level coding takes a wider view on the idea or concept expressed over a number of sentences, instead of focusing on individual words or lines. | Over the course of the project, we coded data continuously noticing actions, choices, events, expressions and similar generic occurrences in our data that somehow related to LEGOs approach to IS architecture generally and specifically to IS modularity.<br>To determine concepts (such as invention, capacity and frustration, and network) and their properties (e.g. efficient/ inefficient, success/failure) in events, actions, decisions, outcomes, and states, we applied an open coding procedure. We assigned occurrences with generic labels reflecting the essence of the occurrence.<br>For example, we assigned the following data point the initial code ‘‘Legacy issues” to denote it as an expression of frustration with the historical setup:<br>“*That is error-prone. [...] We see some pains here and it is tedious work and you need to do it every half year, because we have new products and so forth. [...] As you can see, some of this is designed around the core, because the core is a problem – or was a problem*” |
| Clustering into higher order constructs | Clustering using constant comparison to organize excerpts of raw data into groups (Corbin & Strauss, 2008). | To explore themes of LEGOs approach to IS architecture as expressed in the data, we clustered individual codes in broader categories of related codes.<br>For example, the following quotations contributed towards us considering time constraints and budget constraints as parts of the more general construct of capability constraints, which eventually also come to include lacking technical competence as a constraint. Why we considered these together was because they were often mentioned together by interviewees as a set of restrictions that would prevent situational architects to focus on architectural qualities.<br>*“The preference from the business was that they wanted to start fast and they wanted to have all their features from day one”*<br>*“Urgency [...] trumped that way of thinking. [...] It would have, of course, been much nicer [...]. But at the time it was de- prioritized to do it like that”*<br>*“…project leaders [...] take architectural decisions because of time-pressures, [or] budget constraints…”*<br>*“It was always the functional requirements valued higher and the timely delivery. If compromises had to be done …, they have been on the quality”*<br>*“It allows you to not only do things faster, but also saves you quite a lot of development time, but also cost.”* |
| Identifying decision-alternatives | Continuously assessing the emergent themes in the inductive analysis to identify salient aspects and to direct further inquiry (Corbin & Strauss, 2008) guided the identification of decision-alternatives as forming categories in the data.<br>While not a guiding principle for this task, we note that performing this analytical step resonates with variable definition in QCA which involves considering qualitative differences within variables and when needed make differentiations that adequately capture such differences (Furnari et al., 2020). | Intrigued by LEGO’s measured approach, we documented and inspected the different decision-alternatives considered. Inspecting the instances, we identified qualitative differences among the instances, specifically between two forms of modular decisions. As LEGO preceded with their new approach to IS architecture decisions, the distinction gradually became clearer, and its prevalence as central tenet was manifested by the many and heated discussions about the alternatives.<br>Concretely, the two forms of decision-alternatives were initially discussed and later implemented in the principles of modularity. They were also referred to by interviewees multiple times, either explicitly mentioning the existence of two realistic alternatives or by speaking about the motivation for one of the alternatives reflecting on issues of implementing the principles. For example:<br>*“Back then we did not have these very clearly stated principles for how we would like to work with technology and how we would like to decide on what kind of technologies we would like to put in place. [...] If we had had these things and had the principles we have now, it would have been obvious that the selected solution was not a good choice and that would have saved us a lot of money”* |
| Identifying influencing conditions | In line with the hermeneutic circle, initial discoveries in one part with relevance of the whole triggering further data collection and analysis in interacting parts to reinforce the understanding of the whole | The emerging attention to the distinction between decision-alternatives and the discussions surrounding it sparked our interest in the conditions that were argued as motivating one decision alternative in favor of another.<br>As this direction of analysis emerged, we moved backwards in our already existing empirical material to revisit evidence of conditions, and adapted further inquiries to elaborate on our understanding. In doing so, we found evidence of the argued importance of principles of modularity:<br>*“We are moving forward very quickly in the more digital space and there were really no principles or no overlying roadmap [...]. [This] meant that the decisions were potentially going to be fragmented and the wrong decisions [were] taken for the long term.”*<br>Another example concerns the role of technical competence, which later was integrated as part of the condition internal capability. In reflection in past decisions on modularity, one respondent |

| | | |
|---|---|---|
| | | considered past decisions "less optimal solutions, because [the architects] wanted to stay within [the] platform. [...] I think we got too many solutions that are a little bit artificially engineered, so they fit into what we had and thereby we stuck also to stuff that we know"<br>The initial set of potentially relevant conditions included a set of 10 generic conditions which were further processed in the scoping task of the QCA. |
| Theoretical anchoring of findings | Empirical findings spurred new literature search for theoretical arguments and conceptual development. | Once findings started to emerge, we engaged with existing literature on modularity to place findings in a theoretical context. This led us to consider decision-alternatives as information hiding and modular encapsulation at different levels of granularity.<br>The link to information-hiding emerged through inspiration from quotations such as the one below, which indicated that LEGO was actively aspiring to establish modularity at distinct levels in its IT portfolio.<br>*"This architecture is about modularity and decoupling. [...] We are building many layers in, but we are encapsulating every time everything into a service to enable us for the future change instead of building this big monolith that we have to exchange at once. "*<br>The theoretical anchoring of conditions is explained below as part of the scoping of conditions. |

**Table A3.3**. Phase 2. Methodological guidelines and illustrations

| **Aspect of study** | **Methodological considerations** | **Additional Description** | **Illustrative example (when relevant)** |
|---|---|---|---|
| Building the configurational model | Model construction | The development of configurational framework and definition of outcome of interest (Greckhamer et al., 2018) | Outcome of interests (3 decision alternatives) and tentatively identified influencing conditions were carried over from the first phase inductive analysis. |
| | Theoretical framing | Use of a formal theoretical framework to avoid "potentially spurious findings and little theoretical advancement" (Park et al., 2020, p. 1494). | Use of purposive action theory (Parsons, 1937) and its extension into action formation mechanisms because of its proven capacity in past IS research using configurational analysis and its empirical relevance and resonance with past explanations IS architecture decisions point to the relevance of organizational and solution-level conditions.<br><br>We used purposive action theory to organize the identified conditions in two broad categories and when identifying the decision-rationale (logic) by which combinations of conditions led to decisions. |
| Data collection | Selection of individual points of architecture | 31 theoretically relevant individual PoAs identified from research diary and snowball sampling (Biernacki & Waldorf, 1981). | 10 of 41 initially identified cases theoretically irrelevant and excluded from data collection and analysis. |
| | Choice of interviewees regarding individual PoA | Collecting in-depth data on all 31 points of architecture through 36 follow-up interviews (30-minutes each) (Greckhamer et al., 2018) | Interviewees included architects or product owners involved in decision-making regarding solution architecture. |
| Data analysis | Creating familiarity with data through open coding | The researcher must develop a certain degree of "intimacy" (Griffin & Ragin, 1994) with each one of the cases under consideration and sufficient "case-based knowledge" (Berg-Schlosser & De Meur, 2009) before engaging in the technical operations of QCA.<br><br>Paragraph level coding taking a wider view on the idea or concept expressed in over a number of sentences, instead of focusing on individual words or lines. | Investigating the 31 PoA we identified data extracts that related to outcomes, conditions and mechanisms in the respective decisions.<br><br>Extracts were organized to creating an overview of the PoA as articulated by interview subjects.<br><br>Example: The following quotation was identified as potentially relevant for establishing conditions it referred to a need for a specific solution to incorporate flexibility:<br><br>"*LEGO Life is really living in the agile world. You need hyper-flexibility. Whenever there is a change, they do not ask if it is possible form a technology point of view."*<br><br>Conversely, the following quotation was indirectly speaking about no need for flexibility, since this is considered as standard capability:<br><br>*"The HR capability area is at least at this time....it was very clear that this is something we should look for on the market and not build ourselves. [...] Because this is a very standard capability. Something that all enterprises need and we should basically buy the industry best practice solutions and implement them in a very standardized way."* |
| | Scoping of conditions | Scoping of conditions "by considering as many relevant explanatory attributes as possible, but also simplifying it by conceptualizing similar or coherent attributes as higher-order constructs" (Furnari et al., 2020).<br><br>Using the technique of "complexifying from anchor" (Furnari et al., 2020) that takes its starting point as "one or more attributes that one believes to be important to explaining the outcome" (Furnari et al., 2020).<br><br>Use a formal theoretical framework to avoid spurious theoretical findings (Park et al., 2020) and to ensure theoretical coherence among identified conditions. | When moving to the formal csQCA, we started with a set of inductively identified potential conditions as the baseline. Among these, we identified the change in organizational policy towards IS modularity as a potent anchor condition that we expected would play a central role in the explanation of decisions. We used principles of modularity as our anchor condition and continued to examine the conditions with which this condition was seemingly interacting in decisions.<br><br>Mindful that small-N QCA can effectively handle 4-6 conditions, we combined conditions into more abstract constructs. For example, the condition of inhouse capability come to incorporate three sub-conditions of budget, time and technical competence that all had to do with the internal capacity to deliver a solution meeting the requirements for a specific solution.<br><br>To provide a parsimonious explanation, we also omitted one condition which was identified in the inductive analysis as a consideration ("Informal Engagement of Enterprise Architects" in situated decisions), but with no impact on the outcomes in subsequent analysis.<br><br>In this process, we used our theoretical frame of purposive action (Parsons, 1937) and specifically the broad categories of |

| | | | |
|---|---|---|---|
| | | | organizational and situated level conditions to position our conditions within a theoretical coherent explanation.<br><br>The use of Purposive action frame can be illustrated with establishing the condition of a *formal approach* to architecture decisions as potentially relevant Here, the data pointed to the relevance of the establishment of a technology strategy and what it provided in terms of endorsement of principles and deliberate roles in decisions. Guided by purposive action theory, we considered these as expression of a turn in the organizational norms and values guiding decisions, which we refer to as a formal approach to architecture decisions |
| | Defining threshold and assigning values for variables | Following Rihoux and De Meur (2009), we used substantive/theoretical and technical arguments to the define the thresholds and assign value to variables in each PoA. | Using substantive thresholds, we distinguished between modular/non-modular decisions based on the characterization of modularity (loose coupling and standardized interface), and further between HGM and LGM architecture by the level of encapsulation (microservice vs. application/component).<br><br>Technical thresholds, such as the time of the decision, as the basis for determining the presence of conditions where appropriate.<br><br>Using the definitions and threshold values for decision-alternatives and conditions, we examined the evidence of each PoA to assign a value to each of the variables. As the theoretical frame was solidified, the theoretical meaning of conditions was used to guide reassessment and assignment of value. The assignment of value was iterative and followed adjustment to variable definitions per QCA practice, using direct quotations and observations by the author embedded into the practice to translate data into values for further analysis.<br><br>For example, the following quotation indicated that, in one of the PoAs, the decision was made to implement an IS architecture with high modular granularity:<br><br>*"When LEGO Life came along, we just created a new experience-specific microservice to cater for that specific need and then we reused the whole stack underneath."* |
| | Linking context variables to outcomes as configurations | Guidelines of csQCA as the basis for the configurational analysis (Ragin, 2000, 2008). | Analysis was facilitated by Tosmana (Cronqvist, 2019), a QCA software for small-N csQCA. |
| | Treatment of unobserved configurations in data | We treated unobserved data and configurations conservatively (Ragin, 2000). | We report the data without simplifying assumptions about the logical reminders (missing instances) in our data. |
| Interpreting the results and building causal recipes | Sorting of configurations | Using QCA as a tool to "simplify complex data structures in a logical and holistic manner" (Ragin, 1987, p. viii) which may "help the researcher generate some new insights, which may then be taken as a basis for a further theoretical development" (Berg-Schlosser & De Meur, 2009, p. 16) | We run the QCA three times and sorted configurations based on outcomes generated allowing for identification of condition-combinations leading equivalent outcomes. |
| | Identifying combinatory logic | Based on identified configurations, qualitative data expressing the motivation for decision was revisited to identify the decision-rational explaining the emergence of specific outcomes (Park et al., 2020) in a 'dialogue with the cases' (Berg-Schlosser & De Meur, 2009).<br><br>Corresponding to Huber and Lyytinen's (2025) narrative analysis of configurations in csQCA, we examined decision motivations for (a) expressions of end goals pursued in decisions and (b) arguments for pursuing those goals. Reflecting assumptions held in Purposive Action (Parsons, 1937) we relied on interviewees retrospective | Taking departure in the relevant conditions for each configuration, the decision logic was scrutinized by revisiting the qualitative data to identify the pursuit of goals and the arguments for doing so. This part of the analysis focused on situational architects' perceptions of present conditions, decision-rationale and outcomes.<br><br>For example, the quotation below explained how the absence of a Formal Approach was part of explaining a decision of a non-modular, integral architecture despite the presence of Principles of Modularity.<br><br>*"And that's interesting looking at this example. That is probably a clear case of what we should definitely not do going forward. First of all, we should not have unclarity into the decision-RAID until such a late state and the technology team clearly sitting with a feeling that they had a recommender role, which they actually did not."* |

| | | | |
|---|---|---|---|
| | | rationalization on why these goals were pursued in specific PoAs.<br><br>Analyzing the qualitative data, we used backward and forward chaining (Henfridsson & Yoo, 2014; Pettigrew, 1985), while challenging explanations with other plausible rationalities including pursuit of alternative goals (Klein & Myers, 1999; Sayer, 1992) | As adjustments were made to variables and leveraging the theoretical framing to reflect the goal-oriented action, we also ventured back in the data to re-assess decision rationales. In some instances, multiple rationales were aired preceding decisions, reflecting the conflicting considerations and need for prioritization. Assessing the decision rationale retrospectively, we leveraged observations and familiarity with the cases as we interpreted what appeared to be the main rationale connecting to a specific goal across PoVs.<br><br>The quotation below explained how a specific decision on HGM architecture was based in the pursuit of the goal of future flexibility:<br><br>*"LEGO Life is really living in the agile world. You need hyper-flexibility. Whenever there is a change, they do not ask if it is possible from a technology point of view. We do the change in the app and then you have follow and that is simply not possible if we were locked into a bought system, for instance. So these [cloud-based services] are a lot more flexible and can follow on the business needs as they come".*<br><br>Considering all PoAs associated with a configuration together, we assessed whether the logic from conditions via decision-rationale to outcome, and conversely from outcome via decision-rationale to conditions were representative to all PoAs in consideration. |
| | Naming with simplicity and distinctiveness | Communicating causal recipes to retain 'the essence of configurations' (Misangyi et al., 2017) | Naming of configurations reflected the associated decision-logic. As our understanding to the configurations and the PoAs covered, naming evolved to reflect this understanding. |
| | Capture the whole | Developing an overarching narrative to articulate patterns of the configurational theory as a whole (Misangyi et al., 2017). | "Dialogue with cases" (Ragin, 2000) framed within purposive action theory (Parsons, 1937) and considering theories of modularity to develop empirically and theoretically grounded propositions. |
| | Evaluating the robustness of the findings and face validity | Revisiting and triangulating qualitative evidence to identify inconsistencies between findings and data; presenting configurations to company stakeholders (Greckhamer et al., 2018) for "member checking" to ensure resonance with results (Patton, 2002) | Initial configurations were presented in a town hall meeting to the company's entire IT organization, followed by a discussion with key personnel about specific findings. |
| | Theorizing the whole | Developing an overarching narrative to articulate patterns of the configurational theory as a whole (Misangyi et al., 2017) and crafting an overarching narrative (Furnari et al., 2020) | We examined the broader patterns of decision rationalities in a 'dialogue with cases' (Ragin, 2000) framed within purposive action theory (Parsons, 1937) and considering theories of modularity to develop empirically and theoretically grounded propositions.<br><br>Our theoretical propositions are organized to capture the logical structure as espoused in decision alternatives, conditions, and their combination in decision-rationalities for decisions on modularity in IS. |

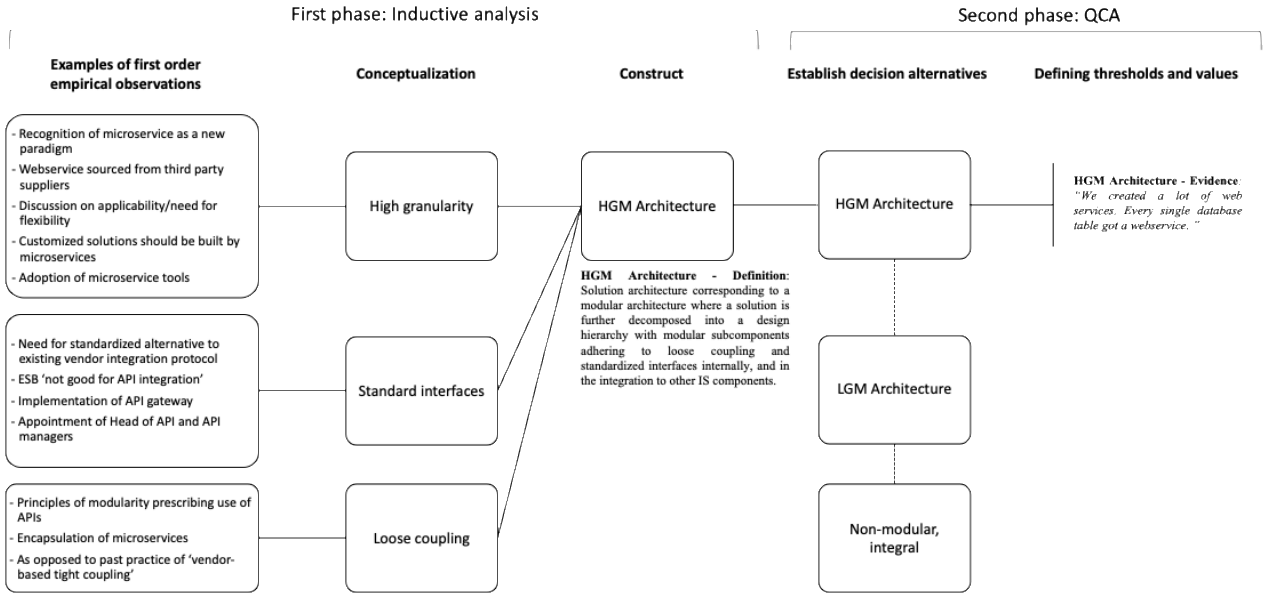



**Figure A3.2.** Exemplification of analytical progression for identification and application of decision alternatives

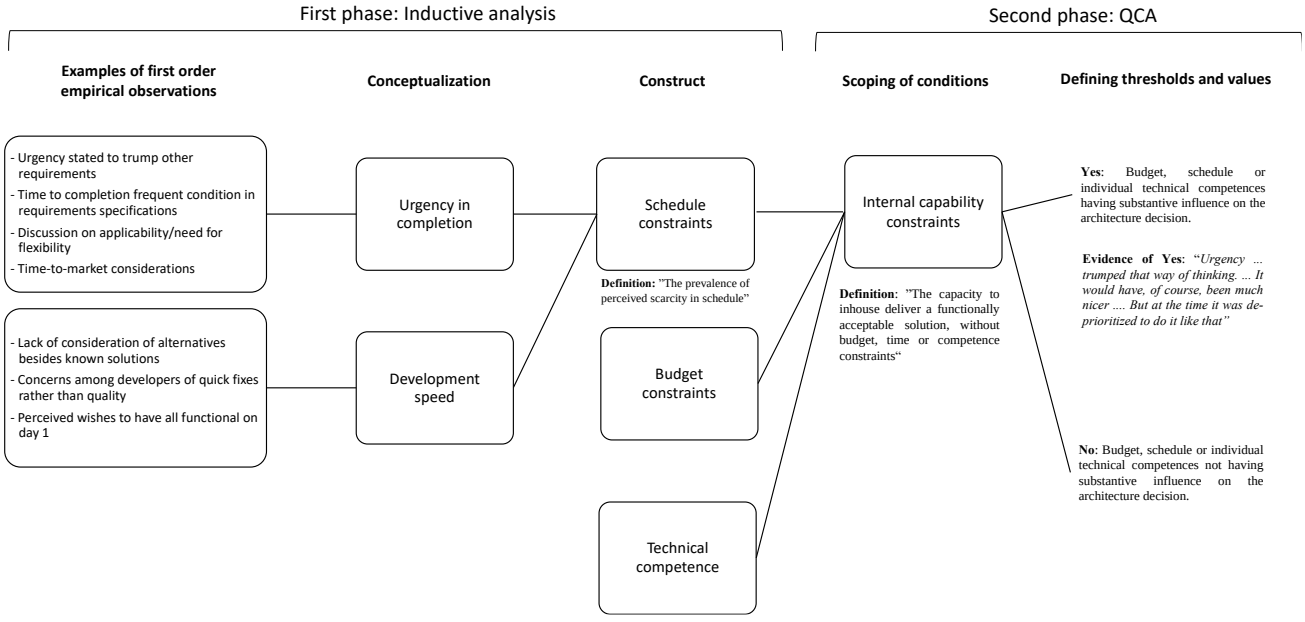



**Figure A3.3** Exemplification of analytical progression for identification and application of conditions

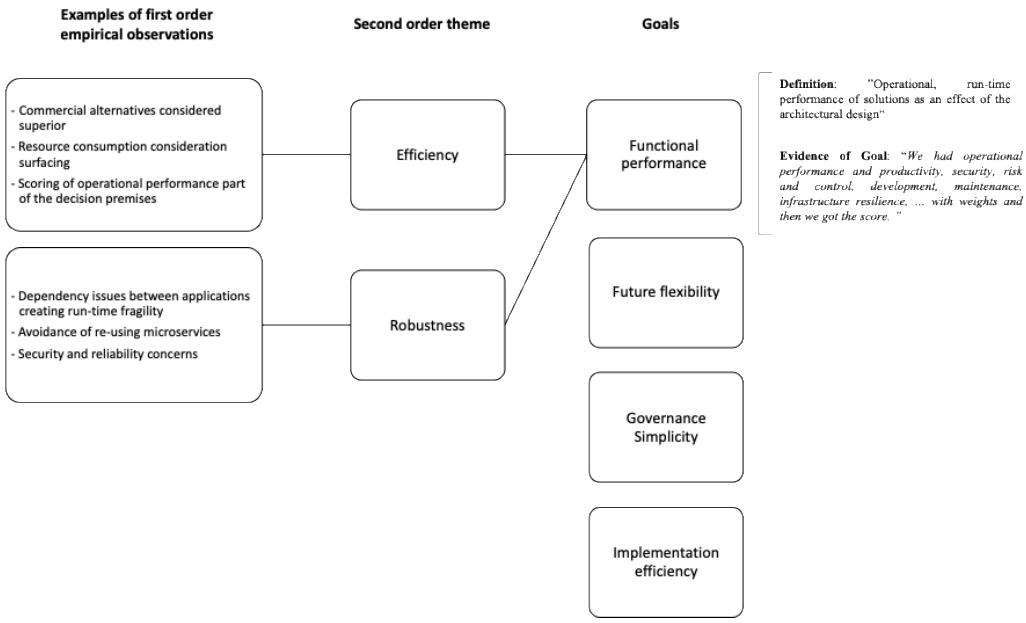



**Figure A3.4** Exemplification of analytical progression for identification of end goals pursued in decisions

## Appendix 4. Outcome and contextual variables in the QCA

**Table A4.1.** Outcome and contextual variables in the QCA

| Variable | Description | | Sample Evidence |
|---|---|---|---|
| Outcomes of interest | | | |
| O.H<br>High modular decomposition (HGM architecture) | Solution architecture corresponding to a modular architecture where a solution is further decomposed into a design hierarchy with modular subcomponents adhering to loose coupling and standardized interfaces internally, and in the integration to other IS components. | | "This architecture is about modularity and decoupling. ... We are building many layers in, but each time we are encapsulating everything into a service to enable us for the future change instead of building this big monolith that we have to exchange at once.'" (Solution architect, LEGO). |
| O.L<br>Low modular decomposition (LGM architecture) | Solution architecture corresponding to a modular architecture where a solution is encapsulated as single modular component and integrated with other components adhering to loose coupling and standardized interfaces. | | "The main reason for buying [Vendor2] was getting a platform that takes care of the changes on the webshop side." (Solution architect, LEGO) |
| O.I<br>Integral architecture | Solution architecture decision not meeting the conditions of decoupled modules and open interfaces between modules. | | "What we ended up with was a very tight coupling between our planning solution and our CRM and our [ERP] – making it really, really hard to remove from our landscape" (Enterprise architect, LEGO). |
| Contextual conditions | | | |
| C.PM<br>Principles of Modularity | Officially approved Principles of Modularity and associated artefacts | **Yes**: Existence of approved principles for modular practice that are supported by a scorecard and a business capability model. | "From a principle point of view, they both lived up to our technology principles – cloud-based, decoupled API, kind of a modern architecture" (Enterprise architect, LEGO) |
| | | **No**: Architecture principles for modular practice and guiding artefacts do not exist. | "[B]ack then we did not have these very clearly stated principles for how we would like to work with technology " (former Solution architect, LEGO). |
| C.FA<br>Formal Approach to architecture. | The formal approach to architecture decisions as laid out in the technology strategy | **Yes**: Existence of a formal approach to architecture decisions. | "[W] we are following the same decision mandate" (Enterprise architect, LEGO) |
| | | **No**: No existence of a formal approach to architecture decisions. | "[T] the technology team [was] clearly sitting with a feeling that they had a recommender role" (former Solution architect, LEGO). |
| C.ID<br>Impact of Differentiation | Strategic roles of business capabilities enabled by IS solutions. | **Yes**: The solution will enable a business capability with desired differentiation for the company. | "The ambitions here are way above what the market is innovating for. […] We took it all the way up to [COO] and it is now agreed that this is a differentiating business area" (former Solution architect, LEGO). |
| | | **No**: The solution will enable a common business capability in the industry with little room for or advantage of differentiation. | "The HR capability area is ... something we should look for on the market and not build ourselves, ... because this is a very standard capability. … [W]e should basically buy the industry best practice solutions and implement them in a very standardized way" (Solution architect, LEGO). |
| C.CC<br>Internal Capability Constraints | The capacity to deliver inhouse a functionally acceptable solution, without budget, time or competence constraints | **Yes**: Budget, schedule or individual technical competences having substantive influence on the architecture decision. | "Urgency ... trumped that way of thinking. ... It would have, of course, been much nicer .... But at the time it was de-prioritized to do it like that" (Solution architect, LEGO). |
| | | **No**: Budget, schedule or individual technical competences not having substantive influence on the architecture decision. | "I think the [Vendor 3] cloud product was not favored. I think it was quite expensive compared to alternatives." (Solution architect, LEGO). |
| C.CS<br>Availability of Commercial Solutions | Supply of dedicated, potentially cloud-based applications that functionally address a specific business need or capability under consideration. | **Yes**: The software market offers at least one solution that is evaluated to be functionally and architecturally suitable. | "Very quickly it was narrowed down to these two candidate solutions. [It] was also the input from our advisors ... that these two candidates were really the ones we should focus on." (former Solution architect, LEGO) |
| | | **No**: The software market does not offer a solution or the solutions offered are evaluated to be inappropriate. | "We have not been able to find a good match on a suite product in this case. I remember we had a talk with Gartner on this and they advised us to move to a more suite product ... But so far we have not really been able to do this" (former Solution architect, LEGO) |

## Appendix 5. Detailed results and empirical illustrations

**Table A5.1.** Detailed results and empirical illustrations

| Configuration description | PoA | Relevance of conditions | Decision rationale | Illustrative example |
|---|---|---|---|---|
| **R.H1 Principle driven differentiation**<br>Areas where LEGO wished to retain the option of differentiating itself beyond industry standards based on in-house development using a microservice architecture.<br>**Architectural Outcome**: O.H – HGM architecture<br>**Contextual conditions**<br>C.PM*C.FA*C.CC*C.ID | • PoA1.<br>• PoA2.<br>• PoA3. | **Organizational conditions**<br>• Principles of modularity and the formal approach perceived as organizational norms for modularity<br>• Solution is perceived to exist in a crucial area for differentiation.<br>**Solution conditions**<br>• HGM architecture is impractical given capability constraints, but feasible if the capability is hired in. | **Goal**<br>• Pursuit of *Future flexibility* to adapt solutions to evolving and unexpected needs<br>**Decision rationale**<br>• The rationale is dominated by normative influence to pursue the goal of *Future flexibility* when Principles of Modularity (C.PM) and Impact of Differentiation (C.ID) are present. A Formal Approach (C.FA) reinforces the priority of architectural qualities over practical concerns of Capability Constraints (c.cc), leading to an HGM decision implemented with external consultants to enable flexibility. The availability of a commercial solution is irrelevant, as its presence does not affect the practicality of an HGM solution. | LEGO identified the need to allow consumers to register their physical LEGO boxes on the LEGO Life social network. This was to be enabled by having consumers scan a code on their LEGO products using a mobile app, which would then be verified by a backend service. The construction of a highly scalable and flexible solution was complicated by tight coupling among pre-existing systems. Despite these constraints, the solution was implemented based on a microservice, serverless architecture in anticipation that the backend systems needed to evolve rapidly to keep up with innovation in mobile technologies and consumers online behavior.<br>"*LEGO Life is really living in the agile world. You need hyper-flexibility. Whenever there is a change, they do not ask if it is possible form a technology point of view. We do the change in the app and then you have follow and that is simply not possible if we were locked into a bought system, for instance. So, these [cloud-based services] are a lot more flexible and can follow on the business needs as they come*" (Solution Architect, LEGO). |
| **R.H2 Market Gap in Offering**<br>Situations where a lack of standard software solutions in the market to meet LEGO's needs led to in-house development using a micro-service architecture.<br>**Architectural Outcome**<br>O.H – HGM architecture<br>**Contextual conditions**<br>C.PM*C.FA*c.cs*c.id | • PoA4.<br>• PoA5.<br>• PoA6.<br>• PoA7.<br>• PoA8. | **Organizational conditions**<br>• Principles of modularity and the formal approach perceived as organizational norms for modularity<br>• The solution is perceived to exist in an area where differentiation does not matter.<br>**Solution conditions**<br>• LGM architecture less practical as lacking commercial alternatives.<br>• HGM architecture practical as capability constraints absent. | **Goal**<br>• Pursuit of *Future flexibility* as an alternative goal when governance simplicity is considered impractical<br>**Decision rationale**<br>• The rationale to pursue the goal of *Future flexibility* was primarily practical. With Principles of Modularity (C.PM) and a Formal Approach (C.FA) present but no Impact of Differentiation (c.id), decision-makers initially sought *Governance simplicity* via an LGM architecture. However, the lack of a commercial solution (c.cs) matching functional requirements made LGM impractical, leading instead to an HGM solution that provided *Future flexibility* as an alternative benefit. Capability constraints are irrelevant because a commercial solution was not seen as available. | The development of a new demand planning solution for business users which aimed to consolidate functionality into a single application and provide data-driven decision-making. LEGO solution architects and business stakeholders jointly concluded that their functional ambitions were beyond what the software market could offer. Therefore, LEGO custom-built the application by developing a microservice-based solution. The resulting architecture maximized the reuse of standard technology components on two cloud-based development platforms.<br>"*We pushed our business counterparts to start thinking about the capabilities they wanted to address. And then we matched that with what technology that pointed at from a higher perspective ... We are doing things that are ... outside what the market is doing. So, actually, we took it all the way up to [the COO] …" (former Solution Architect, LEGO).* |
| **R.H3 Engineering Driven Flexibility**<br>Occasions when visionary solution architects built systems with micro-service | • PoA8.<br>• PoA10.<br>• PoA11. | **Organizational conditions**<br>• Lacking principles of modularity and formal approach, no norm for modularity exists.<br>• Solution is perceived to exist in an area where LEGO endorses differentiation. | **Goal**<br>• Pursuit of *Future flexibility* to adapt solutions to evolving and unexpected needs<br>**Decision rationale**<br>• The rationale reflects a pursuit of the goal of *Future flexibility* despite lacking norms: neither Principles of Modularity (c.pm) | The data engineering team sought to evolve its product-centric big data engine into a platform that could be reused by the wider organization. During this time, the architectural principles had not yet been approved or introduced to the organization. Yet, individual engineers designed the architecture of the to-be platform based on their own previous experience, best practices and trends in the industry as a micro service architecture. |

| | | | | |
|---|---|---|---|---|
| architecture to retain future flexibility.<br><br>**Architectural Outcome**<br>O.H – HGM architecture<br><br>**Contextual conditions**<br>c.pm*c.fa* C.ID*C.CC | | **Solution conditions**<br>• HGM architecture is impractical given capability constraints, but feasible if the capability is hired in. | nor Formal Approach (c.fa) are present. Because the solution is perceived as having high Impact of Differentiation (C.ID), HGM architecture is chosen despite lacking internal capability and higher development costs. The availability of a commercial solution is irrelevant, as engineer-minded solution architects push for *Future flexibility* as the right thing to do. | *"We had series of – I think it is more industry trends - some of it like you said about microservices. ... It has been a fairly evolving platform over time, so one of the core principles was the ability to adapt the platform to a new setup, …."* (Head of Big Data Engineering, LEGO).<br><br>*"We were given free hands to do this. So, architectural quality is also something we have been part of defining – where we said: 'Ok this is what we believe to be right, and this is how we believe to move forward'. … [I]f you are a lead engineer, … you are also going to have to live with your choices …."* (Head of Big Data Engineering, LEGO). |
| **R.L1 Piggy-backing**<br>Instances when LEGO used standard, non-customized software because vendor-provided upgrades offer lower lifetime costs to alternatives.<br><br>**Architectural Outcome**<br>O.L – LGM architecture<br><br>**Contextual conditions**<br>C.PM*c.id*C.CS | • PoA12.<br>• PoA13.<br>• PoA14.<br>• PoA15.<br>• PoA16.<br>• PoA17.<br>• PoA18.<br>• PoA19.<br>• PoA20. | **Organizational conditions**<br>• Perceived organizational norm for modularity as principles of modularity are in place<br>• The perception is that the solution exists in an area where LEGO endorse differentiation<br>**Solution conditions**<br>• LGM architecture is practical given the availability of commercial solutions. | **Goal**<br>• Pursuit of *Governance simplicity* to hand-over responsibility to third-party vendors<br>**Decision rationale**<br>• The rationale reflects a pursuit of the goal of *Governance simplicity* with the presence of the organizational norm of modularity (C.PM), recognizing that flexibility need not be maximized due to low Impact of Differentiation (c.id). The decision is straightforward because suitable Commercial Solutions (C.CS) exist. With no practical constraints, the Formal Approach is irrelevant, and internal capability constraints are not considered in the rationale. | A new procurement platform was required to consolidate vendors and improve the efficiency procurement processes. The assumption was made that procurement is not a strategically differentiating business capability for LEGO, and that the business could rely on vendors for innovation. Following the architectural principles, LEGO evaluated standard solutions and eventually pick one that was then integrated as a component loosely coupled to LEGO's IS landscape via open APIs.<br><br>"*We want to jump on the innovation that our dear software vendor is doing. Because for them, for the software vendor innovation and making new features available is part of the core business, instead of thinking about what kind of improvements and innovations can we at LEGO think of ourselves that we want.*" (Enterprise architect, LEGO).<br><br>"*We used the principles and ... the architecture success scorecard to figure out how … those solutions compared to each other. … In the end the selection has been more a commercial/business decision …, because both solutions live up to our principles" (Enterprise Architect, LEGO).* |
| **R.L2 Technical Excellence**<br>Circumstances when external providers with specialist competence provided technically more advanced solutions than in-house development.<br><br>**Architectural Outcome**<br>O.L – LGM architecture<br><br>**Contextual conditions**<br>C.PM*c.fa*C.ID *C.CS*C.CC | • PoA21.<br>• PoA22. | **Organizational conditions**<br>• Perceived organizational norm for modularity exists as the principles of modularity are in place, but it is not yet reinforced by a formal approach.<br>• The perception is that the solution exists in an area where LEGO endorses differentiation<br>**Solution conditions**<br>• HGM architecture is impractical due to capability constraints, though feasible if capabilities were hired in.<br>• LGM architecture is practical given available commercial solutions with higher performance than LEGO can produce. | **Goal**<br>• Pursuit of functional performance as an architecture quality<br>**Decision rationale**<br>• The rationale reflects a pursuit of the goal of *Functional performance* despite a norm system with Principles of Modularity (C.PM) and high Impact of Differentiation (C.ID) that would prescribe HGM architecture and *Future flexibility*. A lack of capability to develop microservice-based solutions on par with commercial offerings (C.CS) led instead to adopting a commercial solution, encapsulated through an LGM architecture, not for Governance simplicity but for performance. This occurs without a Formal Approach (c.fa), but it is unclear whether this is a necessary or irrelevant condition, given the absence of cases where a Formal Approach is a present condition. | The procurement of a Robot Process Automation tool was initiated by instruction from senior management to explore possibilities for more automation. This triggered a selection process, which included the option that LEGO should build the tool itself to be able to excel in the area. The evaluation concluded that this was not recommended. Instead, a solution from one of the market leaders was chosen. The solution was integrated through APIs if needed to be replaced in the future.<br><br>*"We cannot make these tools as well as a specialized vendor." (IT developer, LEGO)*<br><br>*"These tools are very specialized, so building a tool like this yourself it's not recommendable. … We use the possibilities of API access to integrate with other applications, like our service desk tool and for single sign on and user authentication. … Architecture played an important role here [in the software selection], including the possibilities for integration." (Solution architect, LEGO)* |
| **R.I1 Business as Usual**<br>Situations when LEGO chose to implement a | • PoA23.<br>• PoA24.<br>• PoA25. | **Organizational conditions** | **Goal**<br>• Pursuit of *Implementation efficiency* to lower cost and time | In LEGO, the adoption of components from a preferred vendor's ERP suite was a strategic principle for many years before the introduction of principles of modularity. During the implementation of a new business planning and |

| | | | | |
|---|---|---|---|---|
| convenient integral solution based on prior experience and in-house technical competences.<br><br>**Architectural Outcome**<br>O.I – Integral architecture<br><br>**Contextual conditions**<br>c.pm*c.fa*c.cc | • PoA26. | • Lacking principles of modularity and formal approach, no norm for modularity exists.<br>• The preexisting norm emphasizes cost minimization and operational efficiency.<br>**Solution conditions**<br>• Solutions based on integral architecture are practical given pre-existing competences and a lack of capability constraints. | **Decision rationale**<br>• The decision rationale, without consideration of architectural qualities, reflects a pursuit of the goal of *Implementation efficiency*. With no Principles of Modularity (c.pm) or Formal Approach (c.fa) present, the focus is on leveraging internal development capability to reduce cost and time. Consequently, Impact of Differentiation and alternative Commercial Solutions are not considered in the decision rationale. | consolidation solution, the preferred vendor's corresponding module was the only option evaluated, due to the pre-existence of closely connected solutions.<br><br>*"It was a no-brainer ... We saw a clear benefit from going with the [Vendor1] product… , because it was sitting on the same technology as the rest of the reporting. It was using the same structures, data objects, stuff like that. So we saw that both from an IT-side and from a business architecture side to be the right product …." (former Solution Architect, LEGO)* |
| **R.I2 Business' Favourite Software**<br>Occasions when business departments overruled situational architects' preferred architectural choice to enforce standard solutions.<br><br>**Architectural Outcome**<br>O.I – Integral architecture<br><br>**Contextual conditions**<br>c.pm*c.fa*c.id*C.CS | • PoA27.<br>• PoA28.<br>• PoA29. | **Organizational conditions**<br>• Lacking principles of modularity and formal approach, no perceived norm for modularity exists, although it is recognized at situational level.<br>• Architects are guided by the business's authority and norm for cost minimization and efficiency.<br>• The perception is that the solution does not exist in an area where LEGO endorses differentiation.<br>**Solution conditions**<br>• Solutions based on integral architecture are practical given pre-existing competences<br>• HGM architecture is feasible given apparent lack of capability constraints<br>• LGM architecture is practical given availability of commercial solutions | **Goal**<br>• Pursuit of implementation efficiency to lower cost and time<br>**Decision rationale**<br>• The decision rationale, without consideration of architectural qualities, reflects a pursuit of the goal of *Implementation efficiency*. With no Principles of Modularity (c.pm) or Formal Approach (c.fa) present, the decision is effectively pre-set on an existing commercial solution (C.CS). As the area is not viewed as important for Impact of Differentiation (c.id), situated architects accept that business stakeholders, as budget holders, make the decision without involving architectural qualities in the rationale. | LEGO was organizing the implementation of a large-scale distributed resource planning solution that should enable end-to-end supply chain planning in the company. The architecture decision began with an evaluation of four different alternatives: building the system in-house, composing it out of multiple distinct vendor-provided solutions or buying the entire solution from one of two potential vendors. While from an architecture perspective, flexibility was an important consideration, the technical recommendation to develop a corresponding solution in-house was eventually overruled by business stakeholder's preference for a specific software product, despite its architectural misfit.<br><br>*"The decision was made very differently than we would do it today. It was a decision where ... there was a recommendation made by the technical team. But this was ... more or less completely disregarded and then choosing the solution that business-side of the program team wanted." (former Solution Architect, LEGO)* |
| **R.I3 Principles Deviation**<br>Instances when LEGO lacked the technical skills to follow established architectural principles and had to deviate from them.<br><br>**Architectural Outcome**<br>O.IA – Integral architecture<br><br>**Contextual conditions**<br>C.PM*c.fa*c.cs*C.CC | • PoA30.<br>• PoA31. | **Organizational conditions**<br>• Perceived organizational norm for modularity exists as the principles of modularity are in place, but it is not yet reinforced by a formal approach.<br>**Solution conditions**<br>• HGM architecture is impractical due to capability constraints but could become feasible with capabilities hired in.<br>• LGM architecture is not practical given the lack of available commercial solutions<br>• Integral non-modular architecture practical based on extending pre-existing monolithic architecture | **Goal**<br>• Pursuit of implementation efficiency to lower cost and time<br>**Decision rationale**<br>• The rationale reflects a pursuit of the goal of *Implementation efficiency* despite the presence of Principles of Modularity (C.PM). Lacking the internal capability (C.CC) for microservice development and no commercial solution available, the decision is to extend the existing IT infrastructure with an integral architecture solution. A lack of Formalized Approach (c.fa) allows stakeholders to deviate from principles, and neither Impact of Differentiation nor alternative commercial solutions are considered in the decision rationale. | During the rollout of the consumer service capability to a new country, modifications were for local legal compliance. While data associated with the capability was normally stored on global databases hosted in Denmark, local adaptation was required for this rollout. A solution was designed that would customize the existing ERP system and store the data locally via a de-coupled but proprietary integration to a local database in deviation from LEGO's architectural principles.<br><br>*"Had we had the right resources, it would have been just as easy. I mean [the ERP suite] is perfectly capable of sending a request to a REST [Representational state transfer] API without anything on top. And building a REST API on a Linux server connected to an SQL server is also not the hardest thing to do. But it requires some resources – at least on the Linux server side – that we did not have at that moment. [...] We had the database guy ready. The creation of the database took a couple of hours. The creation of the [integration] took a couple of hours and then [the customization to the ERP suite] did not take that much time either. So it was a fairly quick thing to do" (Solution Architect, LEGO).* |

**References**


Agarwal, R., & Tiwana, A. (2015). Evolvable Systems: Through the Looking Glass of IS. *Information systems research*, *26*(3), 473-479.

Benitez, J., Ray, G., & Henseler, J. (2018). Impact of information technology infrastructure flexibility on mergers and acquisitions. *MIS Quarterly*, *42*(1), 25-44.

Berg-Schlosser, D., & De Meur, G. (2009). Comparative research design: case and variable selection. *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*, 19-32.

Bhatt, G., Emdad, A., Roberts, N., & Grover, V. (2010). Building and leveraging information in dynamic environments: The role of IT infrastructure flexibility as enabler of organizational responsiveness and competitive advantage. *Information & Management*, *47*(7-8), 341-349.

Biernacki, P., & Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological methods & research*, *10*(2), 141-163.

Bush, A. A., Tiwana, A., & Rai, A. (2010). Complementarities between product design modularity and IT infrastructure flexibility in IT-enabled supply chains. *IEEE transactions on Engineering Management*, *57*(2), 240-254.

Corbin, J., & Strauss, A. (2008). Strategies for qualitative data analysis. In *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory* (Vol. 3, pp. 66-86). Sage Publications Inc.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, *13*(1), 3-21.

Cronqvist, L. (2019). *TOSMANA*. Retrieved 26th September from https://www.tosmana.net/

Furnari, S., Crilly, D., Misangyi, V. F., Greckhamer, T., Fiss, P. C., & Aguilera, R. (2020). Capturing causal complexity: Heuristics for configurational theorizing. *Academy of management Review*(ja).

Greckhamer, T., Furnari, S., Fiss, P. C., & Aguilera, R. V. (2018). Studying configurations with qualitative comparative analysis: Best practices in strategy and organization research. *Strategic Organization*, *16*(4), 482-495.

Griffin, L., & Ragin, C. C. (1994). Some observations on formal methods of qualitative analysis. *Sociological methods & research*, *23*(1), 4-21.

Henfridsson, O., & Yoo, Y. (2014). The liminality of trajectory shifts in institutional entrepreneurship. *Organization Science*, *25*(3), 932-950.

Khuntia, J., Kathuria, A., Saldanha, T. J., & Konsynski, B. R. (2019). Benefits of IT-enabled flexibilities for foreign versus local firms in emerging economies. *Journal of Management Information Systems*, *36*(3), 855-892.

Kim, G., Shin, B., Kim, K. K., & Lee, H. G. (2011). IT capabilities, process-oriented dynamic capabilities, and firm financial performance. *Journal of the Association for Information Systems*, *12*(7), 1.

Klein, H., & Myers, M. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *Management Information Systems Quarterly*, *23*(1), 3.

Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, *23*(1), 67-94.

Mikalef, P., Pateli, A., & van de Wetering, R. (2020). IT architecture flexibility and IT governance decentralisation as drivers of IT-enabled dynamic capabilities and competitive performance: The moderating effect of the external environment. *European journal of information systems*, 1-29.

Misangyi, V. F., Greckhamer, T., Furnari, S., Fiss, P. C., Crilly, D., & Aguilera, R. (2017). Embracing causal complexity: The emergence of a neo-configurational perspective. *Journal of management*, *43*(1), 255-282.

Naur, P. (1983). Program development studies based on diaries. In S. P. T. Green, and G. Van der Veer (Ed.), *Psychology of Computer Use* (pp. 159–170). Academic Press.

Park, Y., Fiss, P. C., & El Sawy, O. A. (2020). Theorizing the Multiplicity of Digital Phenomena: The Ecology of Configurations, Causal Recipes, and Guidelines for Applying QCA. *MIS Quarterly*, *44*(4).

Parsons, T. (1937). *The structure of social action*. McGraw-Hill.

Patton, M. Q. (2002). Designing qualitative studies. In M. Q. Patton (Ed.), *Qualitative research and evaluation methods* (Vol. 3, pp. 230-246). Sage Publications.

Pettigrew, A. M. (1985). Contextualist research and the study of organizational change processes.

Ragin, C. C. (1987). *The comparative method: Moving beyond qualitative and quantitative strategies*. Univ of California Press.

Ragin, C. C. (2000). *Fuzzy-set social science*. University of Chicago Press.

Ragin, C. C. (2008). *Redesigning social inquiry: Fuzzy sets and beyond*. University of Chicago Press.

Rihoux, B., & De Meur, G. (2009). Crisp-set qualitative comparative analysis (csQCA). In B. Rihoux & C. C. Ragin (Eds.), *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*. SAGE Publications, Inc.

Saldana, J. (2009). *The Coding Manual for Qualitative Researchers*. SAGE.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003). Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms. *MIS quarterly*, *27*(2), 237-263.

Sarker, S., Xiao, X., & Beaulieu, T. (2013). Guest editorial: Qualitative studies in information systems: A critical review and some guiding principles. *MIS Quarterly, 37*(4), iii-xviii.
Sayer, R. A. (1992). *Method in social science: A realist approach*. Psychology Press.
Tafti, A., Mithas, S., & Krishnan, M. S. (2013). The effect of information technology–enabled flexibility on formation and market value of alliances. *Management science, 59*(1), 207-225.
Tallon, P. P. (2007). A process-oriented perspective on the alignment of information technology and business strategy. *Journal of Management Information Systems, 24*(3), 227-268.
Tallon, P. P., & Pinsonneault, A. (2011). Competing perspectives on the link between strategic information technology alignment and organizational agility: insights from a mediation model. *MIS quarterly, 35*(2), 463-484.
Tiwana, A. (2013). *Platform ecosystems: Aligning architecture, governance, and strategy*. Elsevier Science & Technology.
Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information systems research, 21*(4), 675-687.
Wagner, H.-T., Beimborn, D., & Weitzel, T. (2014). How social capital among information technology and business units drives operational alignment and IT business value. *Journal of management information systems, 31*(1), 241-272.
Walsham, G. (2006). Doing interpretive research. *European journal of information systems, 15*(3), 320-330.
Widjaja, T., & Gregory, R. W. (2020). Monitoring the complexity of IT architectures: design principles and an IT artifact. *Journal of the Association for Information Systems, 21*(3), 4.