Overcoming Gödel in Enterprise Design: Ensuring Completeness of the Enterprise

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ABSTRACT

When using enterprise architecture, it is essential to develop a clear picture of the logical scope of the business in question as part of a strategic business design.

How this boundary is identified and what concepts are involved in the discovery process are not well understood. There is significant inconsistency in the result of the architecture/discovery process.

It was hypothesized that current tools and techniques for ontology development and semantic analysis could be effectively applied to better understand what is at the logical boundary of an enterprise and understand its features and relationships.

A literature review was conducted to identify how practitioners and academia view the subject, and the results organized using structured analysis.

The result is a more complete, internally consistent understanding and description of the logical enterprise boundary.

Through the resulting process for creating this specification of the feature of this boundary, an enterprise is better understood. In this way, the nature and relationships necessary and sufficient to describe the logical enterprise boundary are exposed.

Keywords: Strategy, Strategic Design, Environmental-Force, Business-Service, Value Chain, Value Activity, Business Driver

INTRODUCTION

Gödel's incompleteness theorems are statements of mathematical logic that establish the built-in shortcomings of all formal axiomatic systems capable of modelling basic arithmetic. These results, published by Kurt Gödel in 1931 (Smith, 2007), are significant, both in mathematical logic and in the philosophy of mathematics. What is essential within our understanding of the enterprise is that, while an enterprise may not be a formal system in Gödel's sense (Franzén, 2005), it is helpful to use these ideas as a metaphor and appreciate the enterprise as a set of variables and relationships established by observation, experimentation, or design (Ashby, 1956) and therefore a system, in the informal sense.

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Enterprise Architecture (EA) treats an institution's description as a system that is a set of constructs and relationships to deductions about its design or what its design needs to be. (Zachman, 2003). Enterprise Architecture Frameworks propose rules upon which structures or models constructed through symbols are organised, to make a proposition or statements ~~or a proposition which~~ that are~~is~~ regarded as being established, accepted, or self-evidently valid (The Open Group, 2008)~~, and~~ thus, without additional insight, they violate Gödel's axioms.

Despite the apparent implications of Gödel's theorems in enterprise design, all architecture frameworks, including EAP (Spewack, 1992), IAF (van t Wout & Stahlecker Hofman, 1996), The Open Group Architecture Framework~~TOGAF~~ (The Open Group, 2018), Value Reference Model (Object Management Group [OMG]~~OMG~~, 2018), ArchiMate (The Open Group, 2017), and BizBok Guide (Business Architecture Guild, 2018), do not offer any method of validating the completeness of an enterprise design. For this reason, and in recognition of Gödel's observations on systems, a method outside the enterprise itself is needed to establish the completeness of a proposed design.

Fortunately, in support of Gödel, Gerhard Gentzen ~~has~~ showed~~n~~ that to determine the consistency of any new system, we must construct or uncover another system beyond that. (Gentzen & Szabo, 1969). This, too, is an essential metaphor for enterprise architecture, as it provides a possible way to verify the completeness of an enterprise's design.

BACKGROUND

On the one hand, mathematics is the representation of phenomena in the real world. Mathematical reasoning provides a technique to gain insight or make predictions about the world's nature around us through structured and formal means. Using abstraction and logic, mathematics is applied in a wide range of applications supporting the development of human knowledge about the world around us.

On the other hand, ~~Enterprise Architecture (~~EA~~)~~ is "a well-defined practice for conducting enterprise analysis, design, planning, and implementation, using a comprehensive approach always, for the successful development and execution of strategy. Enterprise architecture seeks to apply structured reasoning to guide organisations through the business, information, process, and technology changes necessary to execute their strategies. These practices utilise the various aspects of an enterprise to identify, motivate, and achieve these changes." (Federation of Enterprise Architecture Professional Organizsations [FEAPO], 2018).

In other words, by attempting to bring structure and repeatability to the discipline of the design of the modern enterprise, ~~Enterprise Architecture~~EA arguably attempts to apply structured engineering discipline and reasoning, with its attendant abstraction and logic, to the identification of the elements of an enterprise from which its structure and behaviour can be made explicit.

From this, tools of ontologies, logic, and other features of formal systems may be applied to ~~enterprise architecture~~EA with some effect.

Beyond Gödel and Gentzen, a third metaphor is useful to explore and understand an enterprise's boundaries. In "On the Origin of Species," Darwin (1859) observed that populations would evolve because of the individual variations that increased or decreased the likelihood of individual plants or animals being "selected" out of their environment for survival and, therefore, for their features to survive ~~(Darwin 1859)~~. In other words, the interaction between the individual life form and its environment is built upon a struggle for survival. This competition is central to both the survival of a natural life form and the survival of an enterprise in its environment.

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Commenté [N.H4]: I moved things around so you could use “are” and “they,” as “they” is a better choice for the latter half (vs. “it”).

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Commenté [N.H6]: The APA asks that abbreviations be spelled out upon first reference, followed by the abbreviation in parentheses only if you are using it at least three times in the paper. As you do not use any of these three other times in this paper, I suggest you spell them all out. The only one I could find a certain definition for within the paper was TOGAF.

Commenté [N.H7]: This entry is confusing because the reference entry is under Gentzen, 1956. It looks like this should reflect that entry instead of this one.

Commenté [N.H8]: The APA asks that if you include an abbreviation after the full term, you then use the abbreviation exclusively in the remainder of the text.

This insight is far greater than that used within The Open Group Architecture FrameworkTOGAF, where a Value Chain diagram is only seen as providing a high-level orientation view of an enterprise and how it interacts with the outside world but limits its purpose to align stakeholders to the high-level functional and organisational context of change. (The Open Group TOGAF, 2018).

This provides the third metaphor that an enterprise must face the requite features to respond to or exploit its environment's conditions like any living thing. Based on these insights, it is hypothesized that Porter's (1985) value activities (Porter, 1985) are the core "genetic code" of an enterprise. For its design to be complete, this code must also be finished.

While Value Activity is the critical component within Porter's (1985) description of how strategy is executed (Porter, 1985), ArchiMate does not include the concept. To facilitate the use of structured modelling or Porter's idea and this analysis, a new object, shown in the figure belowFigure 1, has been adopted.

Porter's (1985) Value Chain is composed of a set of value activities that a firm performs to deliver a valuable product or service for the market (Porter,1985). "The value chain disaggregates at first into its strategically relevant activities in order to understand the behaviour of costs and the existing and potential sources of differentiation" (Porter, 1985, p. 33).

These ideas appear to be very close to Teece's (2009) view of dynamic capabilities, which he sees as providing the ability "(1) to sense and shape opportunities and threats (presumably in the environment), (2) to seize opportunities, (again, seemingly in the environment), and (3) to maintain competitiveness (in the market)." (Teece, 2009 p. 4). This suggestsing that Porter's "value activities" are semantically at least near-equivalents, to Teece's "dynamic capabilities."

A core competency results from a specific set of skills or production techniques that deliver additional value to the customer. These enable an organisation to access a wide variety of markets.

In a 1990 article titled "The Core Competence of the Corporation,", C. K. Prahalad and Gary Hamel illustrated that core competencies lead to the development of core products, which can further build many other products for end-users. Core competencies are developed through continuous improvements over the period rather than a single significant change.

While Barney and Clark (Barney, 2009) sawees the distinction between "dynamic capabilities," "capabilities," and "competencies," etc.and so forth, to be a "labelling battle," he idoes see "capabilities" and "resources" to be mostly interchangeable and therefore, by inference, quite distinct from the value activities, or competencies, that strategically create the ability to perform in the environment within which it operates.

Using a structured model in ArchiMate 3.1 (with the value activities represented with a triangle as the differentiating icon), the form from which the iconic Porter Value Chain might be rendered is shown in Ffigure 1 (Porter, 1985).

In this strategic model, Porter (1985) rendered the enterprise as having five primary activities: (Porter, 1985):

- Inbound Llogistics include the receiving, warehousing, and inventory control of a company's raw materials. This also covers all relationships with suppliers.
- Operations include procedures for converting raw materials into a finished product or service. This includes changing all inputs to ready them as outputs.

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Commenté [N.H12]: The APA asks that abbreviations such as "i.e." and "e.g." and "etc." be used solely within parentheses.

- Outbound Logistics comprises all activities to distribute a final product to a consumer. This includes delivery of the product and provides storage and distribution systems and can be external or internal.
- Marketing and Sales consist of everything done to enhance visibility and target appropriate customers—such as advertising, promotion, and pricing.
- Service includes within its activities to maintain products and enhance consumer experience—customer service, maintenance, repair, refund, and exchange.

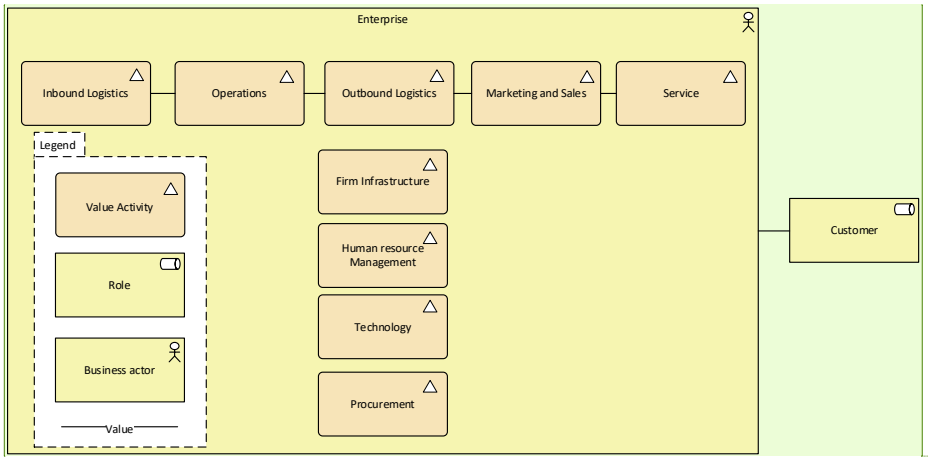

Figure 1 – Porter's Value Chain as a Model

Additionally, the enterprise has~~And~~ four supporting activities~~, which~~ each of which are valuable and needed for the primary Value Activities ~~:~~ (Porter, 1985):

- Firm Infrastructure comprises the support systems that allow operations to be maintained. For Porter, this is an undifferentiated collection of activities, including accounting, legal, and administrative functions
- Human Resource Management is~~:~~ personnel and~~,~~ r~~R~~ecruitment, training, and staff planning.
- Product or Technical Development~~, which~~ includes equipment, hardware, software, procedures, and technical knowledge used during research and development and can include designing and developing manufacturing techniques and automating processes
- Procurement ~~, which~~ is everything involved in the acquisition of inputs, or resources, for the firm.

The model intends to capture and represent the totality of what the enterprise requires to create value and set the stage to locate its differentiation and competitive advantage sources. It does not include those features needed to ensure that policies and strategy are implemented and that required processes are correctly followed. This governance infrastructure is not included within either primary or secondary value activities of a firm and~~,~~ will be ignored within the example that follows.

LIMITATIONS AND CRISIS

The purpose or goal of ~~enterprise architecture~~EA is primarily to identify and align the assets of an enterprise in support of strategic change (Zachman, 2003), and while it is necessary to understand the purpose of an

Commenté [N.H13]: I suggest you capitalize the first letter in “Resource” and “Actor” here.

Commenté [N.H14]: You have this term both with initial caps and in all lowercase. I suggest you choose one style and use it consistently throughout.

enterprise in terms of the value it creates (Kemp, 2021), its is not sufficient; these insights provide no information about its ability to function over time and thereby fulfil its purpose. Without a means to assess an enterprise's business design's soundness, the ability to draw conclusions about the design is questionable. Without a method of assuring the completeness of a design:

- There is no means of determining if the design is complete; that is, does the design contain all the structural and behavioural components needed to deliver value and remain an ongoing concern?
- There is no means of determining if extra, unneeded parts of the enterprise are included in the design, but that have no utility. (Create value for customers or are part of the business's basic fabric and therefore must be done.)

One of the chief symptoms of this is the frequent restructuring of the management authority hierarchy as executives search for ways to answer them. Another sign that the modern enterprise cannot execute its strategy is the increasing rate of enterprises' failure to continue operating concerns to succeed in the market. (Anthony et al., 2018).

The~~As a~~ "top model" of the enterprise expressed in the Porter model is initially compelling, however:

- The model takes a decidedly economic slant to value. Business must be concerned with more than the idea of "monetary worth,"~~,~~ but must, for the modern enterprise, also include ideas of "relative worth, merit, or importance~~:~~" (Sales et al., 2019). Indeed, a business must be concerned with the effectiveness of governance (ISACA, 2012) and have~~be~~ the ability to create differentiating value in the market (Collis & Rukstad, 2008).
- Porter (1985) identifies the specific Value Activities of a particular enterprise's Value Chain as industry-dependent ~~(Porter, 1985,)~~ with no means of identifying these except through the analyst's experience.
- Good categorisation of concepts in any structured representation requires that each concept be atomic, levelled, testable, and repeatable (DAMA, 2019). This is not the case with the value activities in Porter's model, which is none of these~~;~~, for example, marketing and sales are grouped, when frequently there is a need to recognise the specific value created by each, and both Information Technology and Information Management.
- Porter (1985) offers no mechanism for determining either if the value activities are complete or for deciding which activities are primary and which are supporting, except for the generic pattern. ~~(Porter, 1985)~~
- The content and structure of the value chain in Porter's strategy is static. What is needed is a dynamic method that will provide insight into what the enterprise must do "next" to address changes in its condition.

Because of these issues, while the ideas behind the model are powerful, better tools are needed to identify and place the activities within the value chains from an ~~enterprise architecture~~EA perspective.

RESOLUTION

Understanding the set of concepts and categories within any domain of knowledge, their properties, and their relations is essential in forming a clear understanding of the concern~~.~~ (Arp, 2015). A conceptual model or ontology does this (~~Object Management Group [~~OMG~~]~~, 2018). A conceptual model is a graphical language for visualising, specifying, and constructing an area's logic under investigation (OMG, 2018). Graphically, a conceptual model provides a visual representation of the countable nouns embodying the kinds of things of significance in the domain and relationship assertions between pairs of concepts. Thus, a

Commenté [N.H15]: This sentence appears to be incomplete. What did you want to say about Information Technology and Information Management?

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conceptual model aims to express the meaning of terms and concepts domain experts use to discuss the problem and find the correct relationships between different concepts (OMG, 2018). Using these techniques, conceptual models can be used to clarify the meaning of ambiguous terms and, create a context for their use, and therefore aid in ensuring that problems with different interpretations of the terms and concepts can be exposed and eliminated.

The foundational building blocks of the ontology, its components, are then created from the literature review results.

The result of this process is a representation of the things (whether concrete or abstract) that can be named and whose members or instances can be counted. (Spewak, 1992).

For these reasons, the conceptual model is highly suited to gathering insight to explore and organise the concepts used to integrate thinking on enterprise architectureEA, strategy, and other diverse subjects.

A significant challenge with the work is to align and build consistency between the concepts without applying "mental nudges." The reality that creates a difficulty is that few authorities define the terms they use in different ways, or, when definitions are offered, there are issues with the correspondence between the concepts. (Ogden, 1923).

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METHOD

Informally, Gödel's first incompleteness theorem states, that "In any sufficiently strong formal system there are true arithmetical statements that can't be proved (in the system)." (Feferman, 2006).

A formal system is used for inferring theorems (a general proposition not self-evident but proved by a chain of reasoning; a truth established by means of accepted truth) from axioms (a statement or proposition which that is regarded as being established, accepted, or self-evidently true) according to a set of rules. These rules, which are used for carrying out the inference of theorems from axioms, are the logical calculus of the formal system. A formal system is essentially an "axiomatic system". (Hilbert, 1921), which can be used to represent any well-defined system of abstract thought. (such as Enterprise ArchitectureEA is or desires to be).

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By analogy, the point is that: "In any sufficiently strong formal specification of an enterprise there are true statements about its design that can't be proved (in the system)."

Fortunately for both mathematics and enterprise architectureEA, the mathematician Gerhard Gentzen offers a way out. Gentzen observed that if the first (mathematical) system is inside a more significant, consistent, system, that the completeness of the primary system can be accepted as complete (Von Plato, 2007).

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The context of an enterprise, the system external to the enterprise, its environment, is a construct captured in its strategy (Ralston & Wilson, 2006). Depending on the organisation's size and needs, there are up to three layers to enterprise strategy, each with its own view of the enterprise (Mintzberg, 2005) and therefore of the different context in which the elements making up that view exist.

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- Corporate strategy , which contains the core and supporting processes of the corporation, coming together with a story and a focus on the value proposition of the entire business in the context of the environmental variables and relationships that act on it and to which it must respond or exploit.
- Business Strategy, which contains the core and supporting processes of the business unit, coming together with a story and a focus on the value proposition of the business unit in the context of its environmental variables and relationships that act on it and to which it must respond or exploit.

- Functional Ss~~trategy, which~~ contains the core and supporting processes of the function, coming together with a story and a focus on the value proposition of the individual function in the context of its environmental variables and relationships that act on it and to which it must respond or exploit.

Each of the above constructs can bring stakeholders together~~;~~, articulate business strategy~~;~~, identify gaps~~;~~, break down barriers between business units~~;~~, identify funding requirements, scope boundaries, dependencies, and risks for projects; and are great for determining the value activities within the value chain of an enterprise. These all can be seen primarily as a "requirements gathering and specification creating" exercise. This is relevant as Jackson (2001) argued followings~~: (Jackson, 2001)~~:

- The best way to approach requirements analysis is through a process of parallel ~~—~~not hierarchical ~~—~~decomposition of requirements.
- Requirements for value are about relationships in the real world—the environment it which the business operates ~~—~~and not about the enterprise itself.

Using Jackson's insight into the relationship between solutions to problems, it is helpful to recognise that its resolution is in another while the problem is in one location. Further, if we take from Porter that the enterprise/system is the solution needed to create value, then where the problem must, by extension, reside is in the environment to which it responds or seeks to exploit.

The approach uses a conceptual model to explore, gain insight into, and capture the relationships between the concepts of interest, which is needed to understand the relationship between the solution (a well-formed and complete set of Value Activities within the Value Chain of an Enterprise) and the problem, the environment in which it operates.

Using a conceptual model in this way, the factors of interest within the domain can be identified, organised, and presented in a graphical form. To be effective, the concepts being represented must be composed of nouns that are countable (Finkelstein, 1989) and atomic in the context in which they are being manipulated (Date, 2005). In the context of the problem being addressed, the concepts will have logical relationships that can be expressed in verb phrases to create meaningful subject ~~–~~verb ~~–~~object statements that can be tested or applied in the explored domain t~~. T~~o understand the semantics of the problem.

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Within Porter' Value Chain Model, first, value is recognised in terms of its ability to create changes in the level of need within defined communities (Kemp, 2021), whether referred to as an Outcome, which is recognised as the value accrued by a Business Service.

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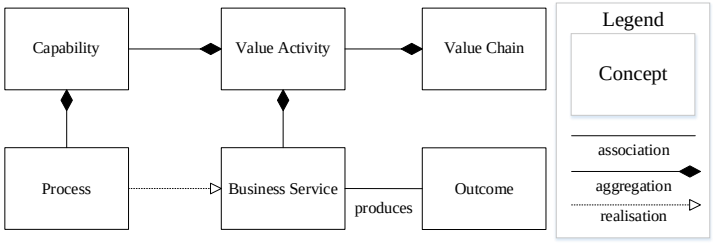

Figure 2 – Conceptual Model of Porter's Value Chain Model

In this model:

- Business Service: While acting as an encapsulation of a set of activities and resources (and without exposing the details of how such resources are produced) (The Open Group, 2017) the service segment of a business is accountable for providing a valued output.
  Or
  It means delivering value to customers by facilitating outcomes customers want to achieve but without the ownership of specific costs and risks~~.~~ (Axelos, 2019).
- Capability: The ability to achieve a defined result under specified conditions (The Open Group, 2017).
- Outcome: What is the benefit? A description of the effect of the change that is achieved by the output in terms of the value of the result, ~~i.e.~~that is, Reduced Unemployment, Reduced Hunger (Collis & Rukstad, 2008).
- Value Activity: C~~c~~reates and adds incremental stakeholder value (Porter, 1995).
- Value Chain: T~~t~~he sets of strategic activities that a firm operating in a specific industry or environment must perform to have the capacity to work and thereby to deliver value for its market~~.~~ (Porter, 1995).

and

- A Value Chain is an assembly (or aggregation) of one or more Value Activities (Porter, 1985).
- A Value Activity is an aggregation of one or more Capabilities (inferred from Porter, 1985).
- Each C~~c~~apability is an aggregation of one or more Processes (The Open Group, 2017).
- A Process realises a Business Service (The Open Group, 2018).
- A Business Service produces a Valued Outcome (The Open Group, 2018).

The challenge is not that these concepts and relationships are not sound, but because Jackson (2001) observed the separation of "solutions space" and "problem space" ~~(Jackson, 2001)~~ and Gödel's Incompleteness Theorem. The problem is identifying which Value Activities are needed within the value chain to form an appropriate value chain. This ~~that~~ will provide the set of required capabilities that will then have the necessary processes to realise the Business S~~s~~ervices ~~that~~ the strategy indicates will provide essential Outcomes.

As the solution is not within this space, it is necessary to look elsewhere.

To recap:

- We acknowledge what both Gödel and Gentzen have to say about determining completeness.
- We know from Jackson (2000) the solution to which Value Activities are needed will not be found in the environment but must be found elsewhere. ~~(Jackson, 2000)~~
- We further know from Darwin (1859) ~~that~~ the ability of a living thing to survive and reproduce is a function of how well it is suited to its environment ~~(Darwin, 1859)~~ and that the ability of an enterprise to survive and thrive is related to the forces that act upon it in an analogous way (Porter, 1985).
- We further know from Porter (1985) that Value Activities exist to create value within the enterprise by responding to or exploiting the environment. ~~(Porter, 1985)~~

We will, therefore~~, begin~~, therefore, by investigating the environment in which the business operates.

The environment in which an enterprise operates is composed of environmental variables that act on other environmental variables through a set of Environmental Relationships to create a system~~.~~ (Ralston & Wilson, 2006).

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Commenté [N.H25]: The reference citation had the year 2001. Does the year need to be changed here, or is this a different source?

These variables may be based on external stakeholders' expectations or interests in the enterprise/system or the market conditions.

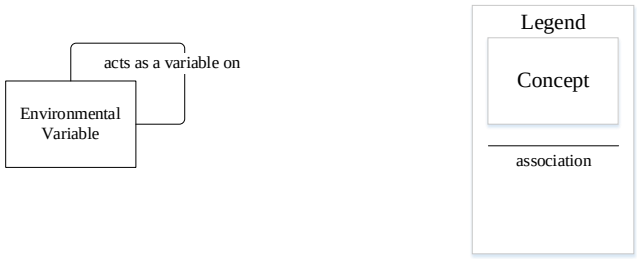


Figure 3 – Conceptual Model of the Environmental System

To be relevant, each environmental variable must act as a force or driver on the enterprise, acting as something to which it must respond or exploit, thus creating a symbiotic relationship between the enterprise and the environmental system in which it operates.

As observed, completeness of the enterprise design previously requireds an understanding of all drivers that act on the enterprise. These are, not just those that motivate the primary and supporting value activities, but also those that motivate the ability to determine and execute strategy and to ensure a suitable level of control is maintained over the enterprise to ensure that processes are followed;, roles and responsibilities are understood and adhered to;, that appropriate capability to take action to resolve any issues identified exists;, and responsibilities are defined;, measuring and reporting is undertaken;, and taking steps are taken to resolve any identified issues are identified.

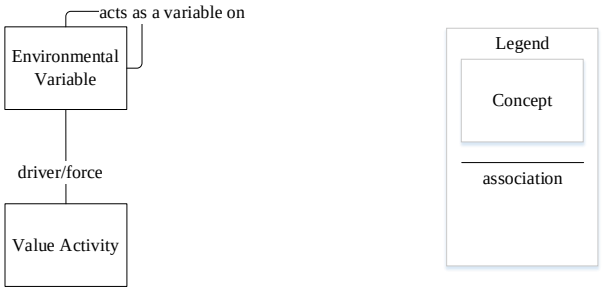


Figure 4 – Concepts and relationships linking the Environmental Drives to the Value Activities

When completing these models, it may be necessary to iterate back and forth between the enterprise view of its value activities and its view of the environmental forces to ensure there is a balance within the environmental system, the value activities within the primary and secondary value chains, and alignment between the two systems. When completed, the result is not an industry or domain-specific view of the enterprise and the enterprise's view of its industry, but a bespoke, enterprise-specific view both of the Value

Activities that are necessary and sufficient for it to operate, and a richer understanding of the environmental conditions that are acting on it.

As each Value Activity addresses one and only one environmental variable, there is a balance between the two systems.

CASE STUDY

Using the insights from the method and analysis, a zero-based design approach may be applied to determine the complete set of the entire chain of events that occur in any enterprise, right from the procurement of its raw materials to the delivery of goods post-sales service.

The approach avoids examining the baggage of the enterprise's organic, emergent design to go right to the heart of the matter, ~~to~~ identifying precisely what is required by an enterprise to create value.

The example is applied to an enterprise operating as a charity, ~~i.e.~~that is, as a funding organisation. The mission statement of the charity is that it will "Help others do good works." ~~.~~ Its business model finds other organisations with the capability to address problems that it identifies as important. It ~~is~~ applies its corporate strategy first to define the priorities for its "good works." ~~.~~ Once a focus has been identified, it seeks out these partners, finding the organisation it believes is best suited to do the work and providing funding from its fundraising. The example organisation recognises that it must maintain a high level of credibility and protect that with reliable controls and processes to be successful.

Environmental Variable	**Description**
Ability to Move Correspondence	The extent to which demands are placed on the organisation to move information in various forms between seeking funding and funding institutions.
Access to External Resources	The extent to which the funding institution can acquire resources it needs but does not have.
Level of Access to Human Resources	The extent to which access to the funding institution acquire and keep people with the skills it needs.
Level of Access to Real Property	The extent to which access to necessary facilities is available.
Level of Compliance to Regulatory Obligations Required	The extent to which the organisation is subject to and must address regulatory oversight.
(Public) Awareness of Availability of Funds	The level of awareness of potential donors or sources of funds about the enterprise's mission and values and the value of what it seeks to accomplish.
Changes in Needs	The extent to which the environmental conditions change.
Confidence in Commitments	The extent to which the enterprise has the assurance that the commitments it enters into can be upheld.
Confidence in Decisions	The degree to which facts support decisions.
Confidence in Process and Results	The degree to which the processes and results are repeatable and evidence-based.
Insight into the Ceondition of the Mmandate	The degree to which the organisation has insight into the problems and challenges within the scope of its mission or mandate.
Level of Demand that Wwork be Efficiently Conducted	The extent to which there is pressure to improve the conduct of the work of the organisation.
Level of Engagement with Stakeholders	The degree to which stakeholders meaningfully interact with the organisation.
Level of Funding	The level of financial resources available for use.
Quality of Competition for Funds	The level of contention for funds offered by the organisation.
Quality of Selected Applications	The quality of the petitions presented to the organisation for funds.

Commenté [N.H26]: This is unclear. Do you mean "The extent to which the funding institution has access to acquire and keep people with the skills it needs"?

Environmental Variable	Description
Level of Understanding of Financial Status	The extent to which the financial health of the organisation is understood.
Value of Funded Projects	The relative worth or regard of initiatives that are provided financial resources.

Table 1 – Example Environmental Variables for Cassae Study

Commenté [N.H27]: Do you mean "that are provided as financial resources." Or "that are provided for financial resources."?

These variables identify the drivers to which the enterprise must have the capacity to respond or to which it will need the wherewithal to act upon. ~~This~~ It should not be considered a requirement that the organisation must necessarily have this capacity itself. Questions about what is within or without the economic or legal unit are questions of implementation or strategy and quite distinct from design.

The example environmental model's propositions or environmental relationships are captured in the environmental relationships that interact between the environmental variables. For the case study, it can be imagined that a philanthropic organisation would hypothesize the relationships between its environmental variables to be as described in the following table ~~following~~.

	Environmental Relationship
1	A change in the Awareness of Availability of Funds may lead to a change in the same direction in the Quality of Competition for Funds.
2	A change in the Awareness of the Availability of Funds tends to result in a change in the same direction of the quality of selected applications.
3	A change in Needs tends to result in a change in the same direction as the level of funding.
4	A change in the Confidence in Commitments tends to result in a change in the same direction as Demands to Respond to Changes in Needs.
5	A change in the Confidence in Commitments tends to result in a change in the same direction as Quality of Selected Applications.
6	As Confidence in Decisions changes, the ability to have confidence in the commitments changes in the same direction.
7	A change in Confidence in Decisions tends to result in the level of engagement with stakeholders changing in the same direction.
8	A change in the Confidence in Process and Results will tend to lead to a change in the same direction in the confidence of decisions.
9	A change in the Confidence in Process and Results triggers a change in the same direction of the level of engagement with stakeholders.
10	A change in the insight into conditions of the mandate will tend to result in a change in the same direction for the level of engagement with stakeholders.
11	A change in the level of compliance of regulatory obligations required tends to result in a difference in the same direction for the confidence in process and results.
12	A change in the level of demand that work be efficiently conducted will tend to result in similar changes in the confidence in process and results.
13	A change in the Level of Funding will tend to result in a change in the same direction of access to real property.
14	A change in the Level of Funding will tend to result in a change in the same direction of access to human resources.
15	A change in the Level of Funding will tend to result in a change in the same direction of the demand that correspondence be moved.
16	A change in the Level of Funding will tend to result in a change in the same direction of the value of funded projects.
17	A change in the Level of Funding will tend to result in a change in the same direction as the access to external resources.

Commenté [N.H28]: The capitalization of the terms in this chart are a bit confusing to me. I cannot see a pattern as to why some of these are capitalized and others are not.

	Environmental Relationship
18	A change in the Quality of Competition for Funds will tend to result in a change in the same direction of the Value oif Funded Projects.
19	A change in the Quality of Selected Applications will tend to result in a change in the same direction of the Value oif Funded Projects.
20	A change in the Understanding of Financial Status will tend to result in a change in the same direction of Awareness of Availability of Funds.
21	A change in Demands to Respond to Changes in Needs will tend to result in a change in the same direction of the Value oif Funded Projects.
22	A change in insight into the condition of the mandate will tend to result in a change in the same direction as the of the Value of Funded Projects.

Table 2 – Example Environmental Relationships for Case Study

Commenté [N.H28]: The capitalization of the terms in this chart are a bit confusing to me. I cannot see a pattern as to why some of these are capitalized and others are not.

Systems Model

To facilitate a clear understanding of the domain, any internal feedback loops, and its overall behaviour, it helps to see the environmental forces and relationships as a single, complete system. Understanding how the system is composed of the major variables included in the domain and acting together as a system is through their respective drivers' interaction.

Model Graphic

As a system is an entity that maintains its existence through the interaction of its parts, being able to see and understand how these parts, the variables, interconnect as a system where the variables act together is central to a good forecast. Based on the premise that each system is perfectly designed and operated to get the results itthey gets, (Hanna, 1988), it is only possible to affect change to the system by understanding that design. By viewing the domain as a system, where the variables can be seen as the parts of the engine that drive its performance, that the influence of trends and opportunities for strategic manipulation of the "machine" is exposed and connects to the enterprise can be made.

Commenté [N.H29]: This is a bit unclear. It is saying the "influence" "can be made." Is that indeed what you intended to say here?

Variables are components of the world for which the forecast is being prepared. Each component represents an element that may influence other aspects in the system or the system's ability to achieve its goal, in this case, local governments' ongoing ability in North America to operate and provide meaningful services to the communities.

Relationships expose the connections between the variables, such that a change in one variable may result in a change in another variable, either in the same or the opposite direction. In the former case, where the relationship causes two variables to move together, an increase in one variable will increase the dependent variable at the end of the arrow with the head. In the latter case, an increase in a variable will lead to a decrease in the variable at the head, or a decrease in the variable will lead to an increase in the dependent element.

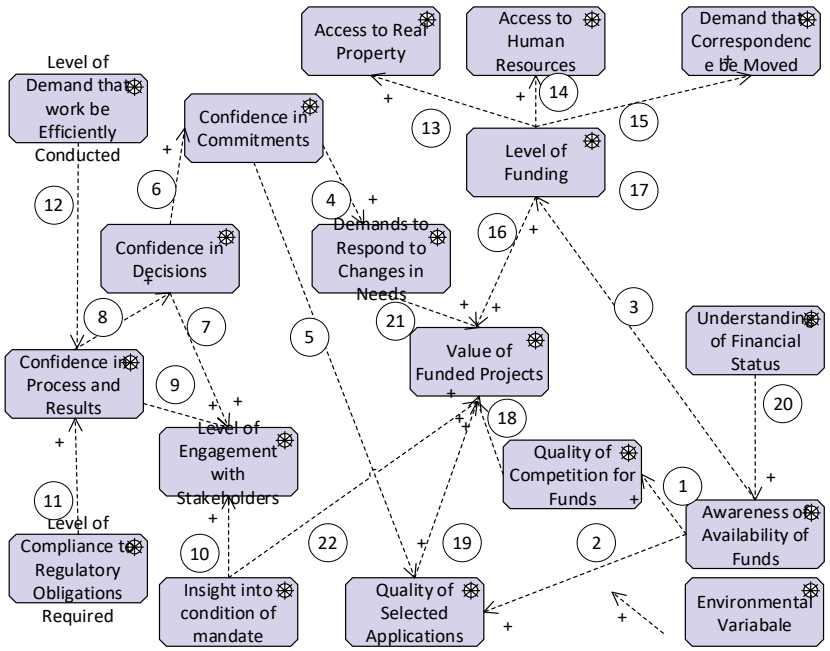


Figure 5 – Example System Dynamics Model of the Environmental Forces Acting on an Enterprise (Corporate Context /Strategy)

It is critical to ensure that the system model variables are atomic (have a single value and meaning). (Codd, 1969). When the variables are not atomic, the results may be ambiguous; the purpose is hidden.

Commenté [N.H30]: I cannot find a corresponding reference citation for this.

For example, the value activities that respond to the environmental forces are presented in the following table.

Value Activity	**Description**	**(Responds to) Environmental Variable**
Application Management	The administration of requests for funding across the approval life cycle	Quality of selected applications
Audit	Independently tests managements control assertions	Confidence in process and results
Competition Management	Stewards the process of assessing requestions for funding	Quality of competition for funds
Competition Promotion	Give publicity to the existence and nature of the opportunities for funding	(Public) awareness of the availability of funds
Financial Management	Is concerned with the ongoing financial viability expenses, cash, and credit, so that the organisation may have the means to carry out its objective as satisfactorily as possible	Level of Understanding of Financial Status
Fund Raising	Seeks financial support for the objectives of the institution	Level of Funding

Commenté [N.H31]: In this column, I cannot understand the pattern of capitalizing some terms and not other terms. Can you take a look at these to ensure they are presented the way you want them?

Value Activity	Description	(Responds to) Environmental Variable
Human Resources	Charged with finding, screening, recruiting, and training job applicants, as well as administering employee-benefit programs	Level of Access to Human Resources
Information Management	Stewards the information resources used by the organisation during its work	Confidence in decisions
Information Technology	Uses computers, digital storage, and networking and other physical devices, technology infrastructure, and processes to create, process, store, secure, and exchange all forms of electronic data	Level of demand that work be efficiently conducted
Legal	Addresses legal issues that may come up during business operations	Confidence in commitments
Mail	Move documents to external stakeholders	Ability to Move Correspondence
Procurement	Acquires suitable resources for the organisation	Access to External Resources
Program Design	Designs the criteria to be used to select between competing applications for funding	Demand to change in response to needs
Real Property	Acquires, stewards, and makes available the building space used by the organisation	Level of Access to Real Property
Regulatory Compliance	Ensures that regulatory obligations are addressed	Level of Compliance to Regulatory Obligations
Stakeholder Relationship Management	Drives the type and frequency of interactions with a person, organisation, social group, or society at large that has a stake in the business	Level of Engagement with Stakeholders
Value of Funded Projects	Delivers the valued outputs to the target community based on the agreement between the two entities	Funded Partner

Table 3 – Example Value Activities for Case Study

Commenté [N.H31]: In this column, I cannot understand the pattern of capitalizing some terms and not other terms. Can you take a look at these to ensure they are presented the way you want them?

Note that it may be necessary to go back and forth between the two views in practice between the environmental and value activities. Each offers its insight, but in the end, when both are aligned with a system, (the enterprise) is created, which is seen to be utterly relative to its environment.

While only the "Funded Partners" is shown as an external actor, and not within the organisation that is the subject of the design, similar decisions might be made for other parts of the organisation; for example, correspondence or mail would typically be delivered by an external courier or similar service; legal services might similarly be obtained through an external service provider, either because the work can be done at a lower cost, or because the organisation does not have or see the need to have the requisite capabilities itself, depending on how the business chooses to shape its business model, mission, etcand so forth.

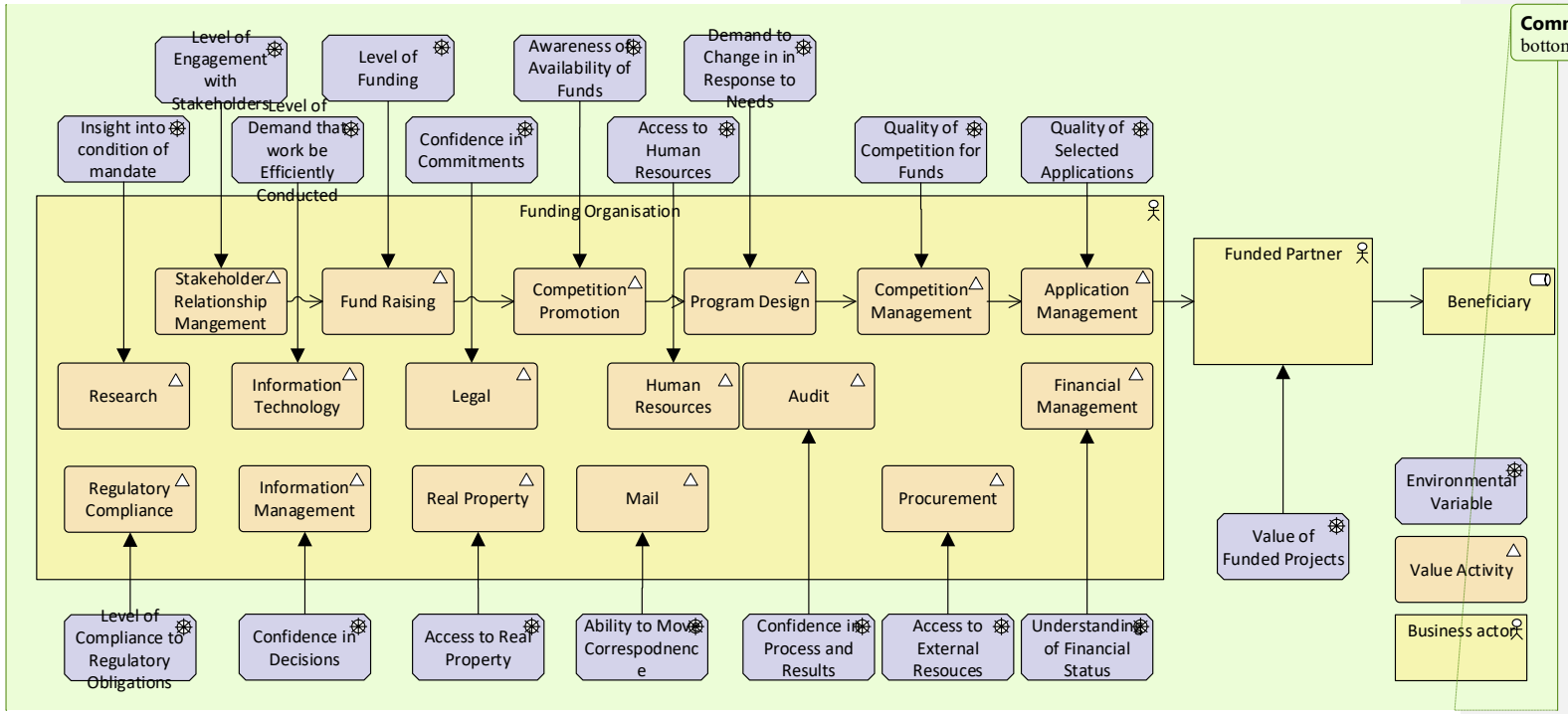


Figure 6 – Example Showing Value Activities M~~m~~otivated by the Driving Environmental Variables for the Case S~~s~~tudy

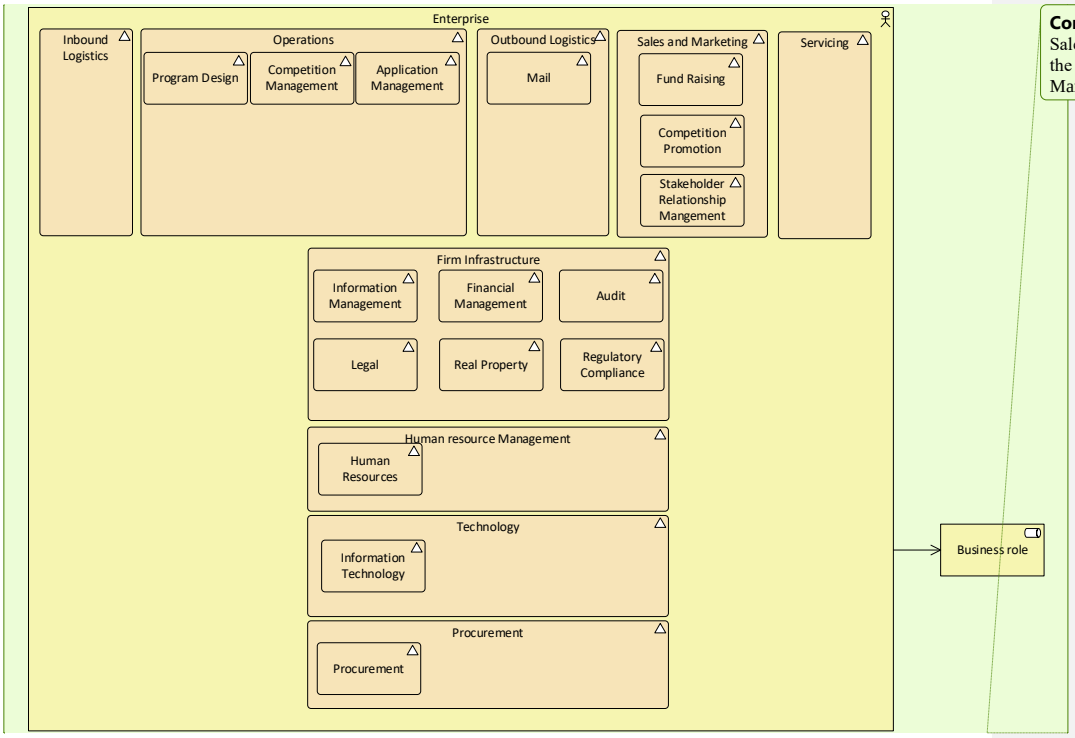
Commenté [N.H32]: Please correct the spelling in the bottom, center block to read "Correspondence"

The atomic value activities from the example can be mapped to Porter's generic Value Activities.

Value Activities that contribute to the final competitive advantages are within the primary Value Chain. The value activities from the example that form the primary value chain are within:

- Operations – Program Design, Competition Management, Application Management
- Outbound Logistics – Mail
- Sales and Marketing – Fund Raising, Competition Promotion, Stakeholder Relationship Management

Inbound Logistics, the receiving and control of raw materials, does not appear as a feature of the example business. This may be due to the volume of raw materials being very low, except for incoming applications, which might be handled directly by "Application Management.". Presumably, with different conditions, the need for such a facility within the business would be recognised by a suitable environmental variable;, i.e the volume of incoming raw materials is an example of a driver that would lead to the business needing to implement the ability to address this.



Commenté [N.H33]: Please correct the spelling under Sales and Marketing to “Management” and please capitalize the first letter in “Resource” in Human Resource Management.

Figure 7 – Example Value Activity Model for the Case Study

Similarly, with no sales, the example enterprise has nothing to maintain and requires no Value Activities that provide servicing.

Value Activities from the example that must be done but do not contribute to competitive advantage can also be mapped to Porter's generic Value Activities within the Secondary Value Chain.

- Firm Infrastructure
- Human Resources Management
- Technology
- Procurement

Porter argues ~~that~~ the primary activities are the source of competitive advantage. Whether this is true is a question of alignment of the value activities to strategy.

When searching for "completeness" of the enterprise, what is missing from Porter's insight of value creation and the proposed method is that the activities ensure ~~that~~ policies and strategy are implemented and ~~that~~ required processes are correctly followed. These processes, including defining the roles and responsibilities, measuring, and reporting, and taking actions to resolve any issues identified, are the third class of "value activities," ~~,~~ the governance activities that are the infrastructure of the engine of the business—these governance processes, together with the set of activities, whether primary or secondary.

LINK TO STRATEGY

Environmental forces drive design at two levels~~:~~; first, for the enterprise itself, as the case study showed, at the corporate strategy level, and~~,~~ t~~T~~hen again, at the internal level, internal forces within the enterprise may be exposed by an internal business or functional strategies to produce further, more delicate chains of value activities.

Figure 3 below shows that, with the three levels of strategic decision making, the enterprise will want to execute this method to capture its features. This leads to identifying the value chains' nested activities that are necessary and sufficient for the forces at play on the business of each being placed, thereby confirming that each part of the total enterprise system can perform.

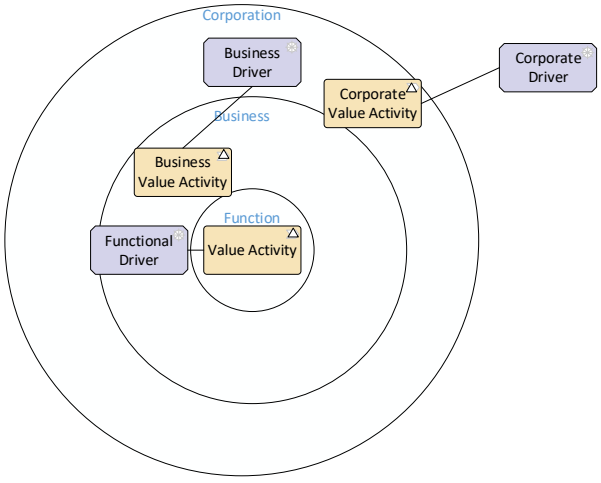


Figure 8 –– Environmental Variables and Value Activity within the Strategy Hierarchy

With the enterprise's scope clearly defined, the importance of the value chain's individual parts can be classified as to whether the strategy identifies each of them as comprising capabilities that are differentiating. Therefore, they are categorised as value maximising, or necessary due to the enterprise's industry, or needed as part of the business and therefore cost minimising.

Comparing the results of this leads to the ability to find any capabilities that, while they may exist in the current organisation, do not support any aspect of the enterprise's operation.

CONCLUSION

The ability to demonstrate the enterprise's scope, establishing what must be within its capacity to act and produce value, is key to all subsequent efforts to design an enterprise and implement a complete design that is an entire bit without unnecessary features.

Further, by adding Darwin's (1859) insight into the nature of the environment and considering an enterprise as a living system interacts with that environment over time ~~(Darwin, 1859)~~, tools and insights are added that make the understanding of value activities and, therefore, strategy to be a dynamic model, rather than ~~a~~ simplye static ~~model~~.

Without a means to assess the soundness of the business design of an enterprise:

- There is no means of determining if the design is complete, that is, ~~does~~ if the design contains all the structural and behavioural components needed to deliver value ~~and~~ or remains an ongoing concern.
- There is no means of determining if there are extra, unneeded parts of the enterprise that are included in the design but ~~that~~ have no utility.
- There is further no means of classifying value activities as being either central to strategy and therefore maximising, or only part of what must be done and being cost minimising.

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Commenté [N.H41]: Please add the publisher

Gentzen, Gerhard (1936), "Die Widerspruchsfreiheit der reinen Zahlentheorie", Mathematische Annalen, 112: 493–565, doi:10.1007/BF01565428 – Translated as "The consistency of arithmetic", in (Gentzen & Szabo 1969). https://archive.org/details/collectedpaperso0000gent

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Commenté [N.H45]: I cannot find a corresponding in-text citation for this.

Commenté [N.H46]: I cannot find a corresponding in-text citation for this.

Sales, T. P., Roelens, B. F. C., Poels, G., Guizzardi, G., Guarino, N., & Mylopoulos, J. (2019). A pattern language for value modeling in ArchiMate. In P. Giorgini & B. Weber (Eds.), *Advanced Information Systems Engineering: 31st International Conference*, CAiSE 2019, Rome, Italy, June 3–7, 2019, Proceedings (pp. 230-245). Springer. Lecture Notes in Computer Science, Vol. 11483 https://doi.org/10.1007/978-3-030-21290-2_15

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