# A Focus on Robustness with ARFIN organizations

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# Multiagent Organizations (MAO) in a few words

- **MAOs**: strategies for decomposing complex organizational goals into simpler **sub-tasks**, allocating them to **roles**.
- Current models target open systems by allocating and enforcing rights and duties to agents about the tasks to realize.
- Agents' activities are choreographed by issueing obligations.

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- Agents' activities are choreographed by issueing obligations.

- **Agents**: by adopting roles agents execute the corresponding tasks in a distributed, coordinated, and regulated fashion.
- Each **agent**:
  - carries out part of the organizational goal,
  - depends on the **collaboration** of others to perform its task.

# Agents lose sight of the overall process

- They are focussed on the achievement of the assigned sub-goals
- Ignore the place of their goals in the big picture
- Who should give restitution to whom?
- Who is interested in my activities ("*stakeholders*")?

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# Direction: MAO need "agent responsabilization"

Need of introducing some explicit representation of some **relationships** agents have with the others, their mutual "dependences", and, more broadly, of the dependence of the organization on its members for what concerns the *realization of the business process*.

# What about Commitments?

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The creditor should be the interested party but the choice to create the commitment and towards whom is totally up to the debtor.

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**We need a different kind of relationship**

An agreement between the parts, respecting a specification inside an organization, whereby the **legitimacy** for one agent to ask information about a subgoal is accepted by **both** the involved agents

We resort on the notions of **responsibility** and **accountability**.

# Accountability

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**(Grant and Keohane, 2005)**

"Accountability presupposes a relationship between power-wielders and those holding them accountable where there is a general recognition of the **legitimacy** of (1) the operative standards for **accountability** and (2) the authority of the parties to the relationship (one to **exercise particular powers** and the other to **hold them to account**)."

# Accountability and Responsibility

As a consequence, accountability is **grounded on perceived/assumed responsibility**, deriving from **recognition of legitimacy** of exercising some power, and of the claim-right to hold the responsible to account.

# Accountability and Robustness

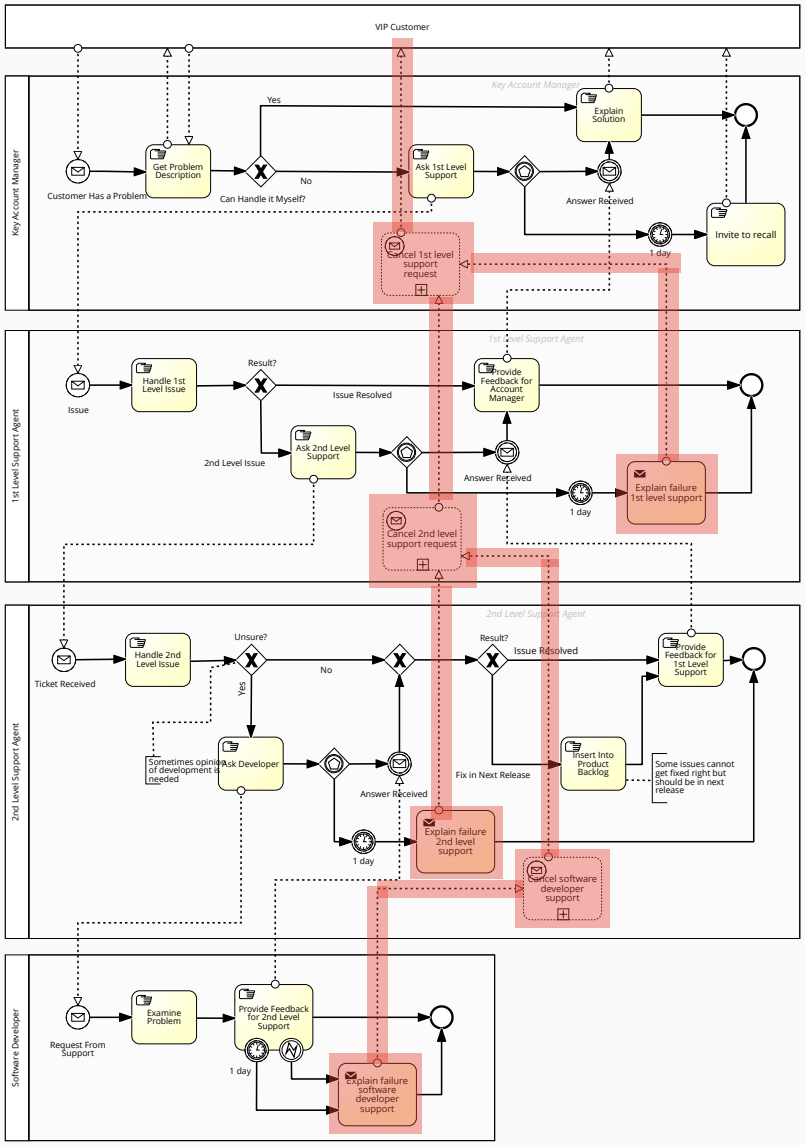
- **Accountable software**: software that, under given conditions, provides account of what was achieved or what went wrong.
- System results to be **robust**, that is capable **to keep on working** within **acceptable standards** despite something abnormal occurs.

# Exception handling

Exception handling as straightforward special case of accountability, where the agents have the agreement that the account-taker is **always** interested in **feedback**, on occurrence of some exceptions. Thereby, the account-giver proactively provides such feedback **without waiting for a request**

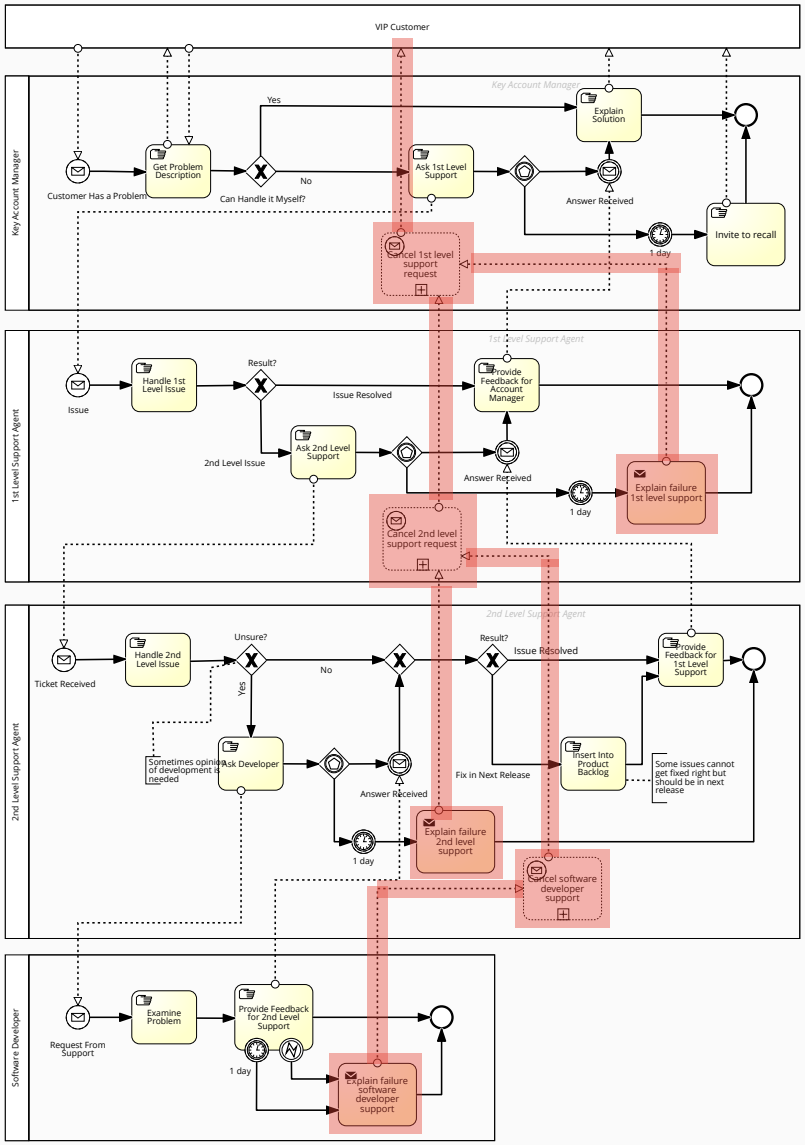
# Exception Handling: a special case of accountability

- Exception specification mechanism captures the way in which a process is interested into another



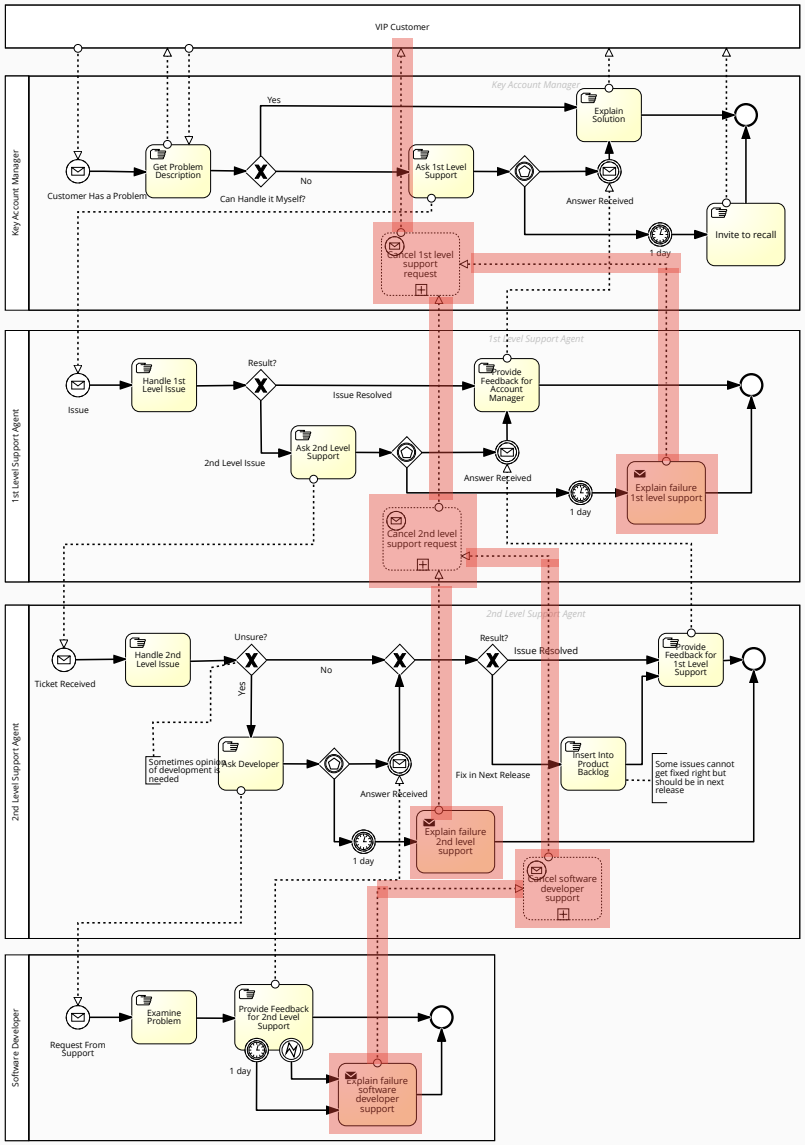
# Exception Handling: a special case of accountability

- Exception specification mechanism captures the way in which a process is interested into another
- A process can react to abnormal events (exceptions), possibly encompassing contextual information provided by others in their decision processes



# Exception Handling

- The driver of such a process is the attempt to execute up to the preset standards, possibly through self-regulation, by adapting either the execution or the organization itself
- This process heavily relies on the accounts that the involved agents are expected to produce.



# ARFIN Organizations

**Agent organization**

A process being collectively executed by a number of agents. Agents produce and answer to institutional events, and need to coordinate to accomplish the organizational goal.

**ARFIN organization**

A MAO that includes: an **accountability specification**, a **responsibility distribution**, an **accountability fitting**, and some **norms**.

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(Baldoni et al., 2018) proposes to complement the specification of an organization with accountability and responsibility specifications.

Such an extension provides organizations with an additional infrastructure that captures who **should** give account to whom for certain states of the organization, and who **can** ask for such feedbacks.

# Specifying accountabilities

**Accountability** $\mathrm{A}(x, y, r, u)$

$x$, the account-giver, is accountable towards $y$, the account-taker, for the condition $u$ when the condition $r$ (*context*) holds.

**Accountability specification**

It is a set **A** of accountabilities $\mathrm{A}(x, y, r, u)$.

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*Accountability is grounded on control and expectation*:

- expectation is naturally conveyed with the accountability itself;
- (knowlegde) control is recursively verified on the structure of $u$: $x$ controls $u$ either directly (it is in position of causing $u$) or indirectly by relying on accountabilities.

# Specifying responsibilities

**Responsibility specification**

A responsibility specification $\mathrm{R}(x, q)$ expresses an expectation on any agent playing role $x$ on pursuing condition $q$ ($x$ is entitled and should have the capabilities of bringing about $q$).

**Responsibility assumption**: for playing role $x$ an agent should declare to accept to be considered in the position of causing $q$.

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**R** denotes a responsibility distribution, that is a set of responsibility assumptions.

# Accountability Fitting

**Accountability Fitting $\mathbf{R} \rightsquigarrow \mathbb{A}$ ("$\mathbf{R}$ fits $\mathbb{A}$" )**

Given:

- $\mathbb{A}$: a set of accountability specifications;
- $\mathbf{R}$: a responsibility distribution;

We say that $\mathbf{R} \rightsquigarrow \mathbb{A}$ when $\exists\ \mathbf{A} \in \mathbb{A}$ such that $\forall\ \mathrm{A}(x, y, r, u) \in \mathbf{A}$, $\exists\ \mathrm{R}(x, q) \in \mathbf{R}$ such that, for some actualization $\widehat{q}$, $(u/r)/\widehat{q} \equiv \top$.

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Given $\mathrm{R}(x, a \cdot b \cdot c)$, $\mathrm{A}(x, y, d \cdot e, d \cdot a \cdot c)$,
$q$ is $a \cdot b \cdot c$, $r$ is $d \cdot e$, $u$ is $d \cdot a \cdot c$,
then $(u/r)/\widehat{q}$ is $(d \cdot a \cdot c)/(d \cdot e)/(a \cdot b \cdot c)$.

# Accountability fitting

**Intuitively ...**

Accountability fitting captures a properly defined organization that is guaranteed to properly distribute responsibilities.

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$\mathbf{R} \rightsquigarrow \mathbb{A}$ provides a specification the agents **must explicitly conform to**, when enacting organizational roles.

# Accountability Fitting with exceptions

Given a set of events $\mathcal{U}$, let $\mathcal{E}$ be a set of exceptional events, that is, $\mathcal{E} \cap \mathcal{U} = \emptyset$ and each event $e \in \mathcal{E}$ is complementary to possibly many events in $\mathcal{U}$.

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$\mathcal{F} \subseteq \mathcal{U} \times \mathcal{E}$ maps events in $\mathcal{U}$ to their corresponding complementary ones in $\mathcal{E}$.

- An expression $u$ is *touched* by an exception $e \in \mathcal{E}$ if for at least one event $w$ occurring in $u$, $(w, e) \in \mathcal{F}$.
- An accountability relationships $\mathrm{A}(x, y, r, u)$ is *touched* by the occurrence of event $e$ when $w$ occurs in $u$ and $(w, e) \in \mathcal{F}$.

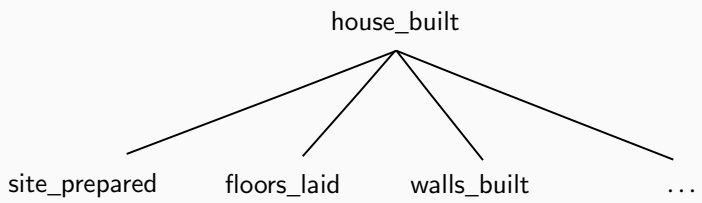
**Compliance with exceptions**

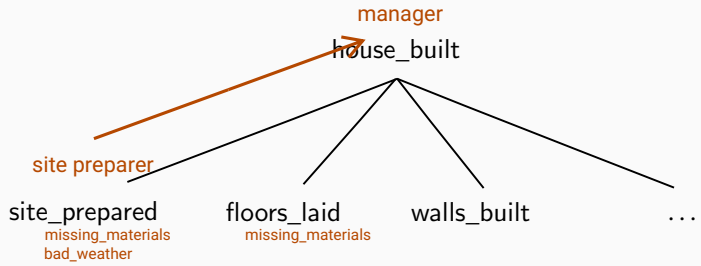
Let $[\mathbf{R} \rightsquigarrow \mathbf{A}]_{\mathcal{F}}$ be an accountability fitting characterized by $\mathcal{F}$. An ARFIN organization is compliant with $[\mathbf{R} \rightsquigarrow \mathbf{A}]_{\mathcal{F}}$ if, whenever $\mathrm{A}(x, y, r, u) \in \mathbf{A}$ is touched by an event $e \in \mathcal{E}$, an account about $u$ is requested to $x$ by default.

# MAO $\rightarrow$ ARFIN

Complementing a functional decomposition with an accountability fitting with exceptions $[\mathbf{R} \rightsquigarrow \mathbf{A}]_{\mathcal{F}}$ turns an organization (implemented in JaCaMo) into a particular kind of ARFIN organization that considers **abnormal situations explicitly**.

# The building house example




- R(*site preparer*, site_prepared) $\in$ **R**
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**Abnormal situations/exceptions**

Let us suppose the site preparer *agent may fail* because of (1) missing materials or (2) bad weather.

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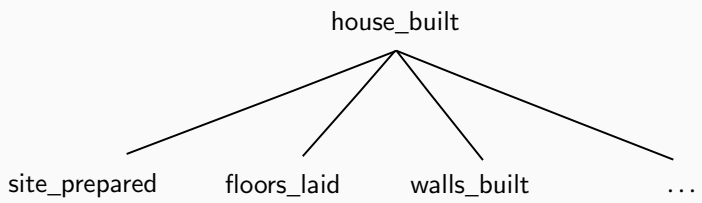


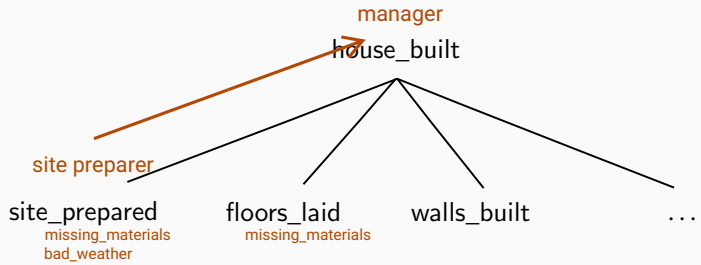


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- *Site preparer* is *touched* by the two exceptional events *missing_material* and *bad_weather*.
- Thus (*site_prepared*, *missing_material*) $\in \mathcal{F}$ and (*site_prepared*, *bad_weather*) $\in \mathcal{F}$.

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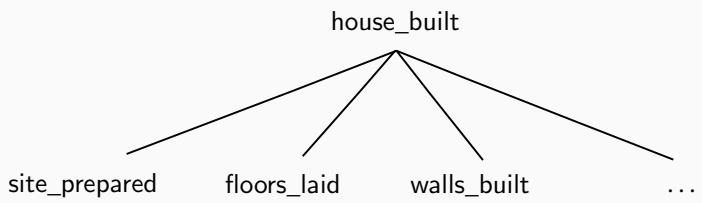


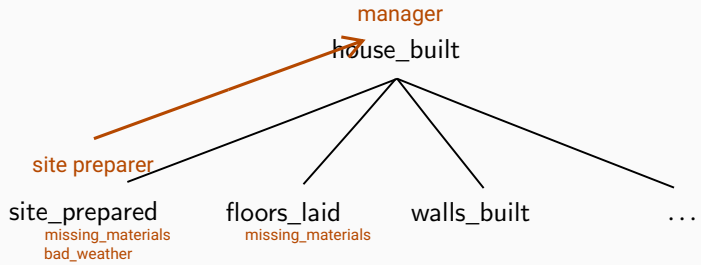


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- Thus (*site_prepared*, *missing_material*) $\in \mathcal{F}$ and (*site_prepared*, *bad_weather*) $\in \mathcal{F}$.

$[\mathbf{R} \rightsquigarrow \mathbf{A}]_{\mathcal{F}}$ characterizes what kinds of exceptional events should be reported and to who.

# The building house example

- Extending the functional decomposition by **enriching goal specifications** with the list of the respective relevant exceptional events that could thwart goal achievement.
- The responsible agent will be asked to **report** either the successful achievement or the **exception causing the failure**.

```
<functional-specification>

 <scheme id="build_house_sch">

  <goal id="house_built">
   <plan operator="sequence">
     <goal id="site_prepared" ttf="20 minutes">
       <exceptions>
         <exception id="missing_material" />
         <exception id="bad_weather" />
       </exceptions>
     </goal>
     <goal id="floors_laid" ttf="25 minutes">
       <exceptions>
         <exception id="bad_weather" />
         ...
       </exceptions>
     </goal>
     <goal id="walls_built" ttf="40 minutes" />
     ...
   </plan>
   <catch>
     <goal id="weather_emergency" handles="bad_weather">

       <plan operator="..."> ... </plan>
     </goal>
     <goal id="materials" handles="missing_material">
       <plan operator="sequence">
         <goal id="materials_got" ttf="10 minutes" />
          ...
       </plan>
     </goal>
    </catch>
  </goal>

    ...

 </scheme>

</functional-specification>
```

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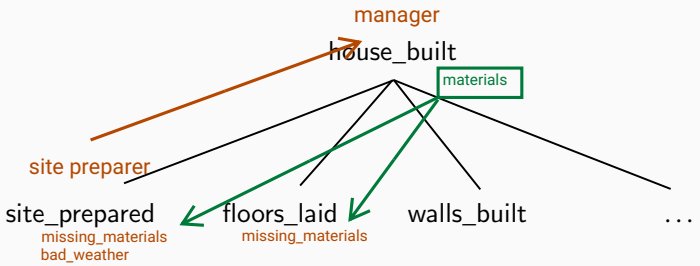


- The specification includes which **handlers** will be activated to tackle the *abnormal situations* (*exception handlers*).
- Handlers are modelled as goals to be achieved in alternative to the failed one (the goal of the agent who receives the exception).

```
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2
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29          <goal id="materials_got" ttf="10 minutes" />
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32      </goal>
33    </catch>
34   </goal>
35
36     ...
37
38  </scheme>
39
40  </functional-specification>
```

# Conclusions

- Robustness in software systems is "the ability of a software to keep an 'acceptable' behavior [...] in spite of exceptional or unforeseen execution conditions (such as the unavailability of system resources, communication failures, invalid or stressful inputs, etc.)."
- Accountability is a **non-functional requirement** of a software system, that has a positive impact on **system robustness**, since it captures an **infrastructure** for analysing the organization's performance and take action if deemed necessary
- Beyond exceptions, accountability is an enabler for organization **adaptation**, both in **structure** and in **strategies**

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