MODELLING THE QUANTIFICATION OF VERACITY REQUIREMENTS TECHNICAL DEBT

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RBOP Update --- Veracity Spearhead 2 day get together, October 2023

AGENDA

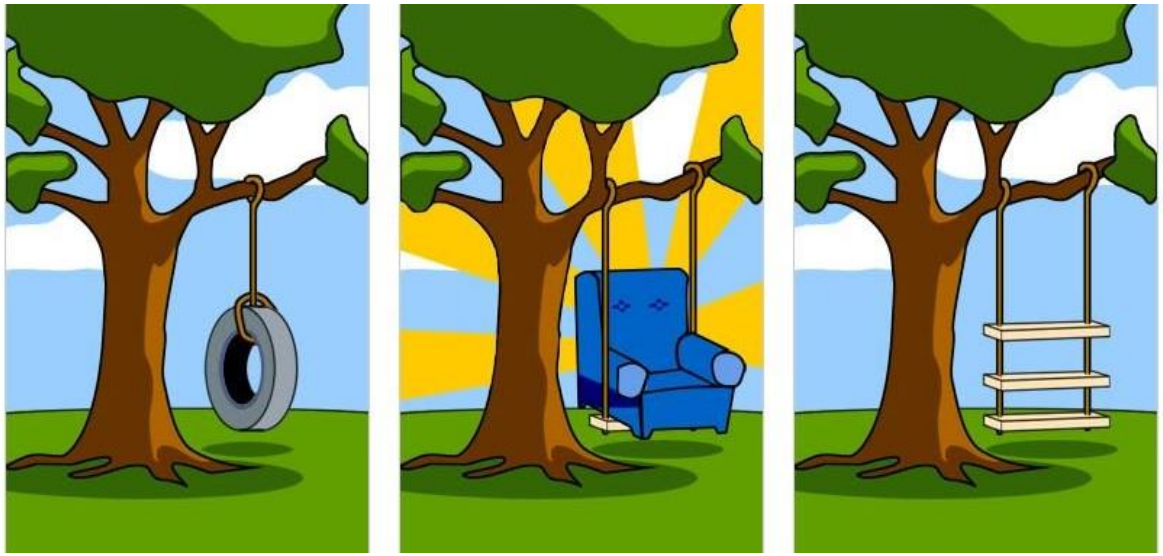
- ❑ Motivation
- ❑ Research Roadmap
- ❑ RE 23 Paper
- ❑ Discussion

MOTIVATION

Software Requirements play a crucial role in the development of a software systems

Gathering requirements right and delivering the product that offers the best value to the end-users,
is essential for the success of software systems

Motivation



Ernst et. al, *presented the* ***earliest definition on RTD*** *(in 2012) —* the distance between the optimal requirements specification and the actual system implementation, under domain assumptions and constraints.

- **Stakeholders make sub-optimal decisions concerning requirements during gathering, formalizing and implementing requirements** --- *e.g., missing to capture important user needs, introducing ambiguities when formalizing the requirements, insufficient implementation of requirements*
- **Requirements Technical Debt (RTD)** captures the consequences of such sub-optimal decisions (in terms of costs)
- **Accumulating RTD can result in developing the wrong product for the customer or in delays in product delivery**
- Therefore, RTD must be managed.
- To manage RTD, it must be quantified.
- *But how can we quantify RTD?*
- **We establish a theoretical foundation** focusing on RTD and its quantification in the RE 23 paper.

Software Requirements concerning Veracity --- That is, *software requirements related to* ***truth, trust, authenticity, provenance and integrity of data and human interactions***

Veracity is becoming a main concern in the present-day software systems and software requirements concerning veracity play a crucial role in the development of software systems

RTD applies to all types of software requirements: functional and non-functional

Software requirements concerning veracity can be either functional or non-functional or both, depending on the software system

We hypothesize that the impact of RTD could be much higher **in the case of software requirements concerning veracity** and the quantification of RTD could support decision-making to better manage RTD

RESEARCH ROADMAP

Research Roadmap

- **Step 1 (Completed): Establishing a theoretical foundation for Requirements Technical Debt (RTD) quantification**
  - Systematic Mapping Study (SMS) completed
  - Conceptual model (developed)
  - RE 23 paper (published)
  - Invitation to extend as a Journal paper for the REJ Special Issue (paper in writing)

- **Step 2 (in Progress): Anonymous Online Questionnaire for Practitioners**
  - Study Goal: Understand **if and how** practitioners **formally or informally quantify RTD**, and **how quantifying could support decision-making** for better managing RTD for **software requirements in general and for software requirements concerning veracity**
  - Target audience: software professionals from different domains
  - Study Design (done)
  - Ethics application (submitted)
  - Currently obtaining feedback from experts on the questionnaire

- **Step 3: Modelling the quantification of veracity RTD**
  - Understand the implications for software requirements concerning veracity from questionnaire data
  - Refining the conceptual model to capture specifics for veracity

RE 23 PAPER

Quantifying Requirements Technical Debt

A SYSTEMATIC MAPPING STUDY AND A CONCEPTUAL MODEL

Judith Perera**, Ewan Tempero, Yu-Cheng Tu and **Kelly Blincoe

The original talk was presented at the 31st IEEE International Requirements Engineering Conference in Hannover, Germany held from 4-8th Sep 23

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Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

RQ1: What can we learn about quantifying RTD from approaches proposed in RTD literature?
--- *answered via the **SMS***

RQ2: How can we model the quantification of RTD?
--- *answered via the **development of the conceptual model***

- **RQ1: SMS**
  - We followed recommendations given by Kitchenham et al. and Petersen et al. ; ***Search, Article Screening, Reference snowballing, Data Extraction, Analysis and Synthesis***
  - 7 articles were finally included out of 87 articles obtained from the digital databases: ***SCOPUS, IEEE, ACM, SpringerLink, ScienceDirect***
  - Search Query and Incl/Excl criteria focused exclusively on RTD literature and quantification of RTD

- **RQ2: Development of the Conceptual Model**
  - In part, by examining what constitutes RTD quantification ***informed by its code-related counter part*** in our previous work
  - and ***in part, by examining the literature captured via our SMS***

- Replication package for this work: https://zenodo.org/record/7754413
- Previous work: https://arxiv.org/abs/2303.06535
- Avgeriou et al.'s work that informed our previous work: https://drops.dagstuhl.de/opus/volltexte/2016/6693/

- **RQ1: Learnings from literature**
  - Different authors discuss different definitions of RTD --- there is no commonly agreed formal definition
  - There is no commonly agreed way to quantify RTD
  - *Other findings included* --- Concepts related to RTD quantification, Metrics, Tools and Supported RTDM activities, RTDM strategies, RTD causes, indicators and consequences of RTD, challenges associated with RTD *(Details are in the paper)*

- This led us to formally define RTD and model RTD quantification via RQ2

- **RQ2: Conceptual model**
  - Enabled a deeper understanding of RTD and its quantification --- *key observations in later slides*
  - Enabled the comparison of RTD and software code-related TD quantification
  - Enables the comparison of different RTD quantification approaches and serves as a reference point to develop new quantification approaches

Results (SMS): Definitions of RTD

- ***Ernst et. al,*** *presents the earliest definition on RTD (in 2012)* — the distance between the optimal requirements specification and the actual system implementation, under domain assumptions and constraints.

- ***Lenarduzzi and Fucci*** *provide a more comprehensive definition of RTD* by extending the definition of RTD by Ernst to include upstream activities involving the elicitation of requirements and their translation into specifications --- three types of RTD: Type 0, 1, and 2, based on **Incomplete Users' needs, Requirement Smells, and Mismatch implementation**, respectively.

- ***Abad et. al,*** --- trade-offs in the System Requirements Specification (SRS) that result from intentional strategic decisions or unintentionally due to the changes in the context

- ***Other definitions included*** --- insufficient, incomplete or outdated requirements (intentionally or unintentionally), failures in SRS, poor or partial implementation of requirements

"Requirements Technical Debt (RTD) captures the **consequences of sub-optimal decisions made concerning requirements**, either deliberately (for strategic gains) or inadvertently (due to changes in context), **during the identification, formalization, and implementation of requirements**."

Results (Model development): RTD Quantification Model (RTDQM)

- **The Requirements Technical Debt Quantification Model (RTDQM)** --- A conceptual model that captures the concepts related to RTD quantification and the relationships between them

- **Model concepts and relationships were informed by the SMS literature and our previous work**
  - We identified 57 concepts related to RTD quantification from the primary studies
  - Based on our previous work, we categorized them into **categories: process or time, cost, benefit, and probability** which contained 32, 16, 1, 2 concepts, respectively
  - An **abstracted** set of **14 concepts went into the conceptual model**

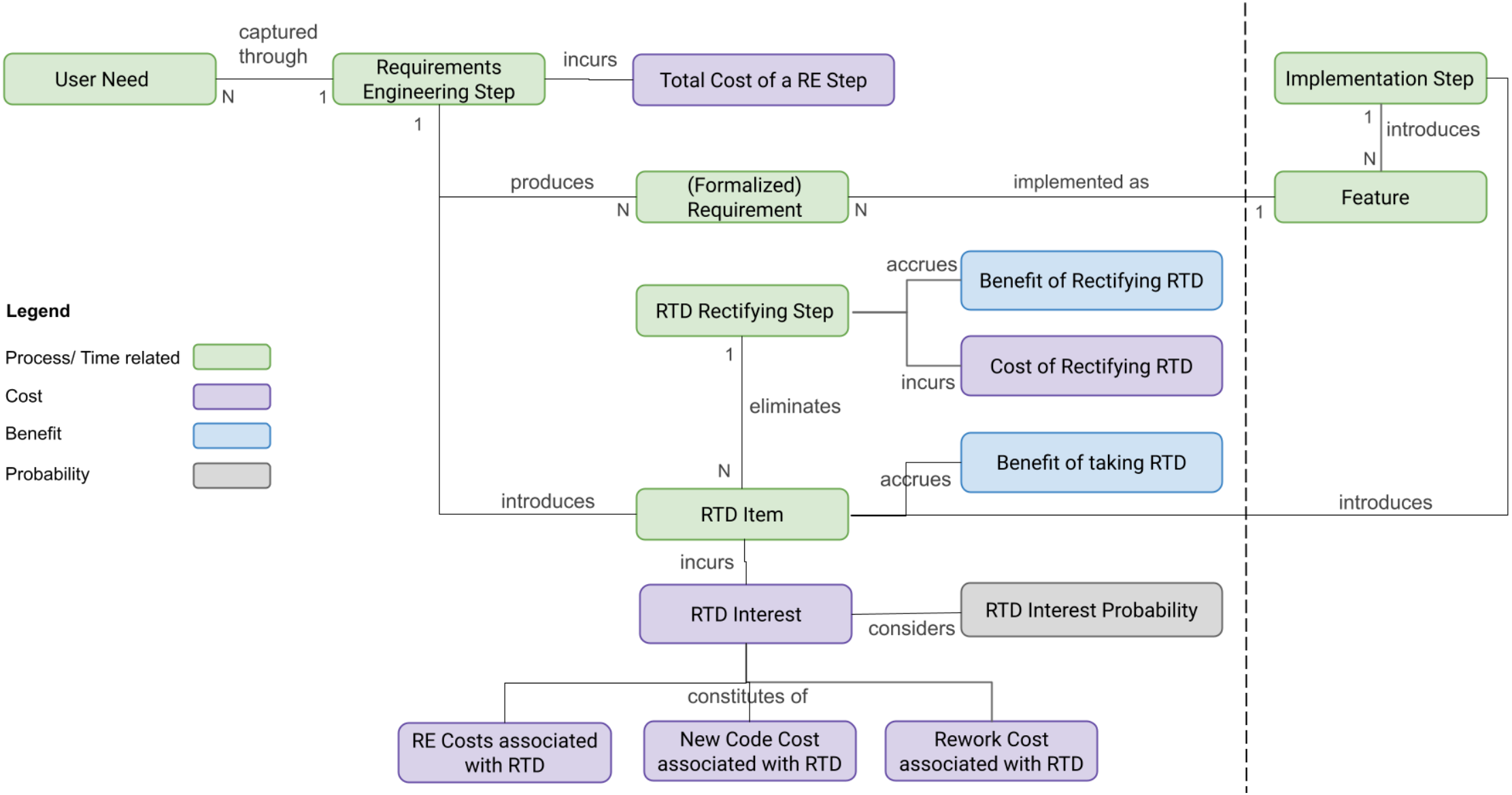
Results (Model development): RTD Quantification Model (RTDQM)

RTD Quantification Concept	Informed by Literature		Informed by TDQM
	density (d)	groundness (g)	TDQM counterpart
User Need	4	4	-
Requirements Engineering Step	3	3	Development Step
Total Cost of a RE Step	3	3	Total Cost of a Dev. Step
(Formalized) Requirement	7	14	Feature
RTD Item	5	12	TD Item
RTD Rectifying Step	1	3	TD Refactoring Step
Cost of Rectifying (or remediating)	4	7	Cost of Refactoring
RTD Interest	5	11	TD Interest
New Code Cost associated with RTD	3	6	New Code Cost associated with TD
Rework Cost associated with RTD	3	6	Rework Cost associated with TD
RE Cost associated with RTD	1	1	-
Benefit of Rectifying	0	0	Benefit of Refactoring
Benefit of taking RTD	1	1	Benefit of taking TD
RTD Interest Probability	1	1	Interest Probability

RTD QUANTIFICATION CONCEPTS — D - NUM. OF SOURCES, G - NUM. OF CONCEPTS EXTRACTED FROM A SOURCE THAT RELATES TO A RTD CONCEPT

- The **Technical Debt Quantification Model (TDQM)** in our previous work: https://arxiv.org/abs/2303.06535

Results (Model development): RTD Quantification Model (RTDQM)



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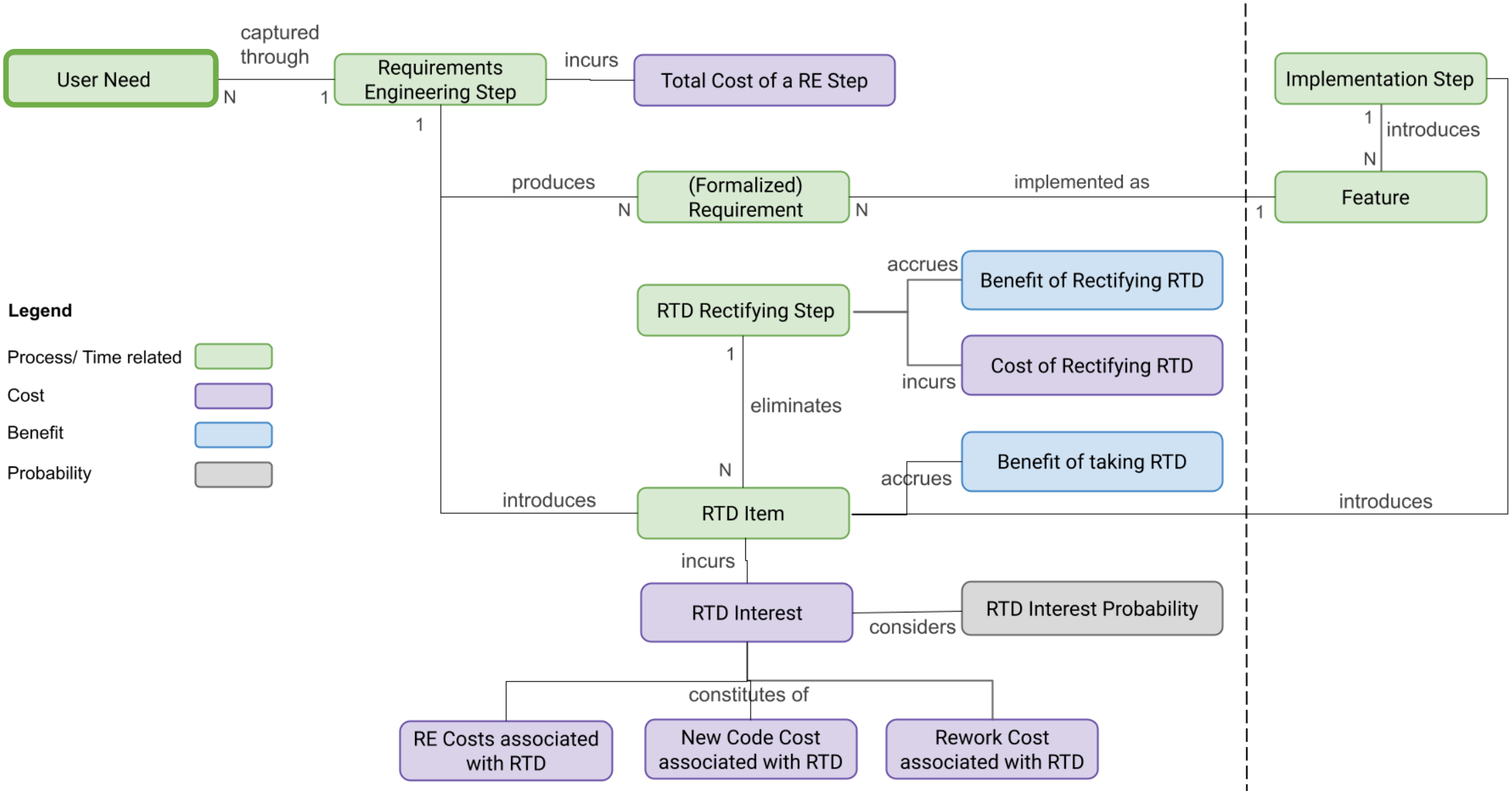

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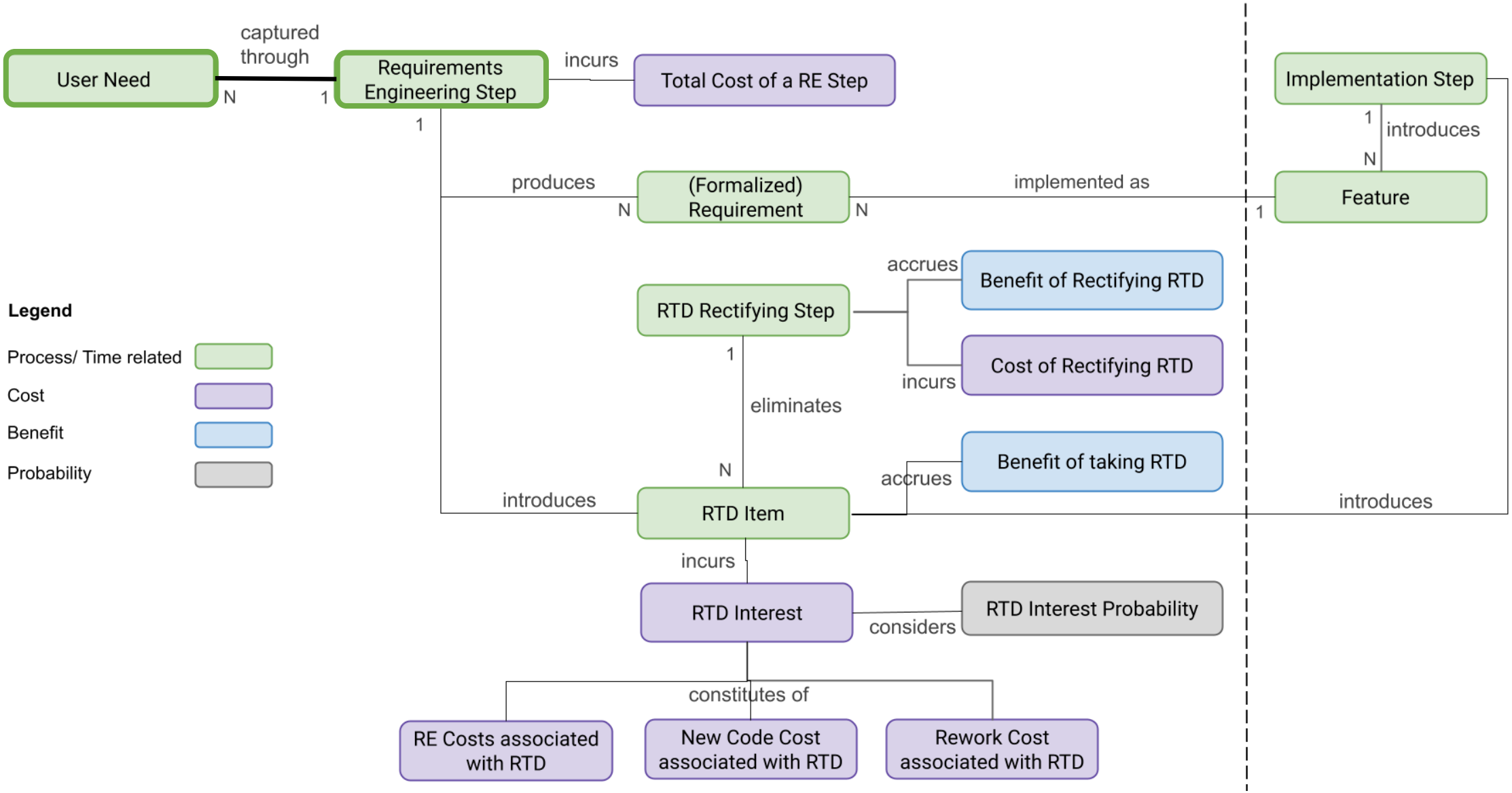

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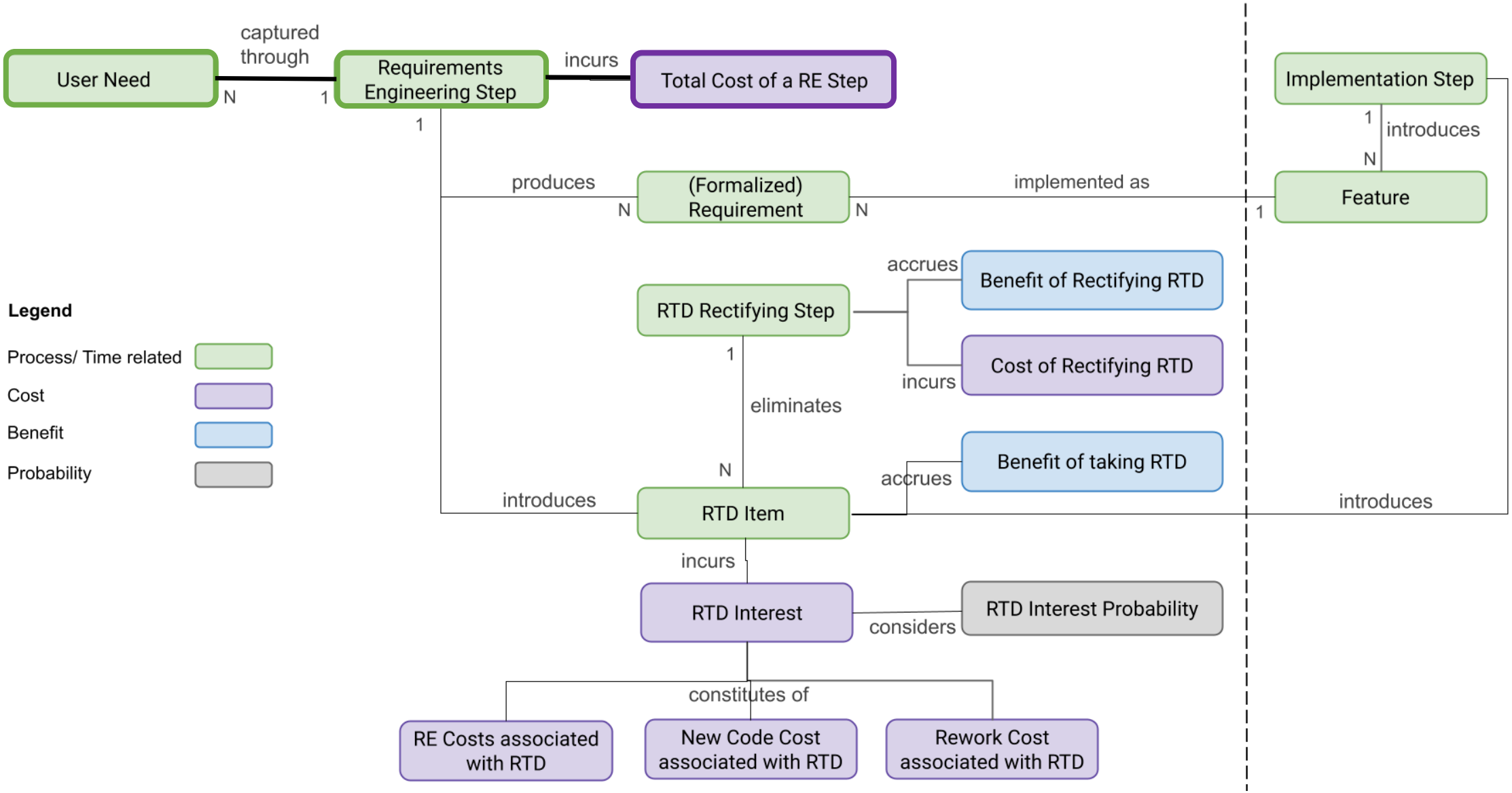

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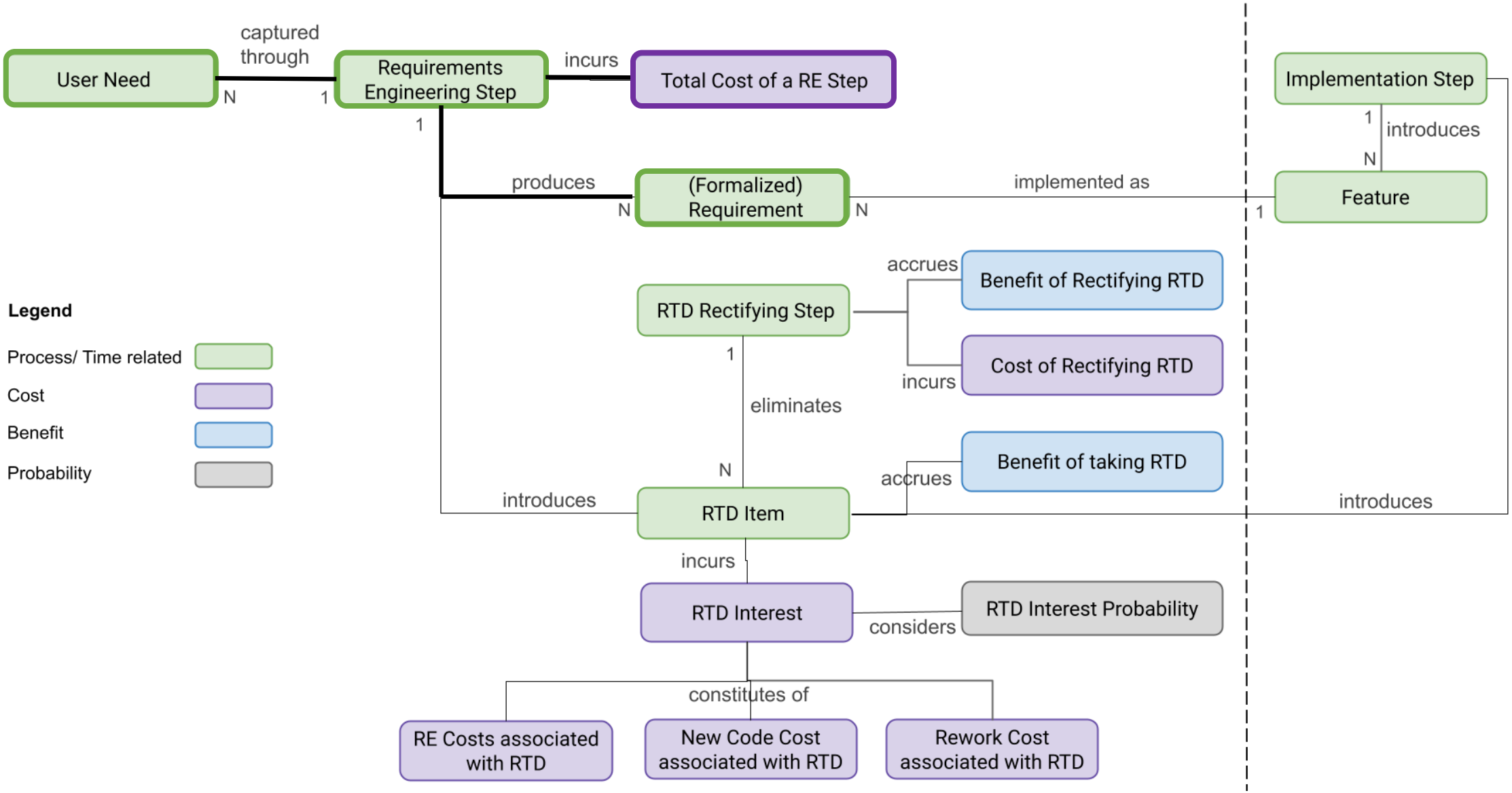

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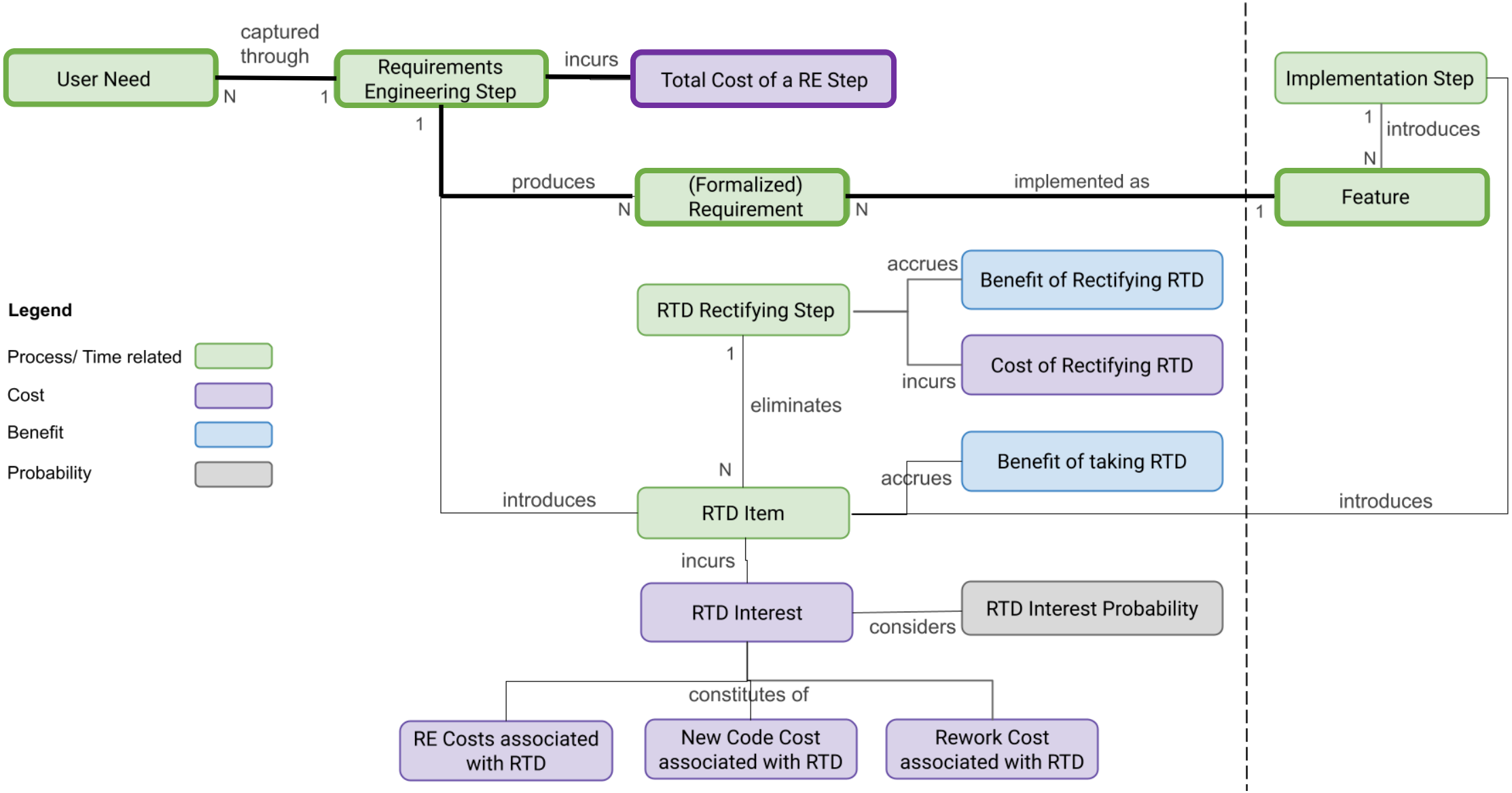

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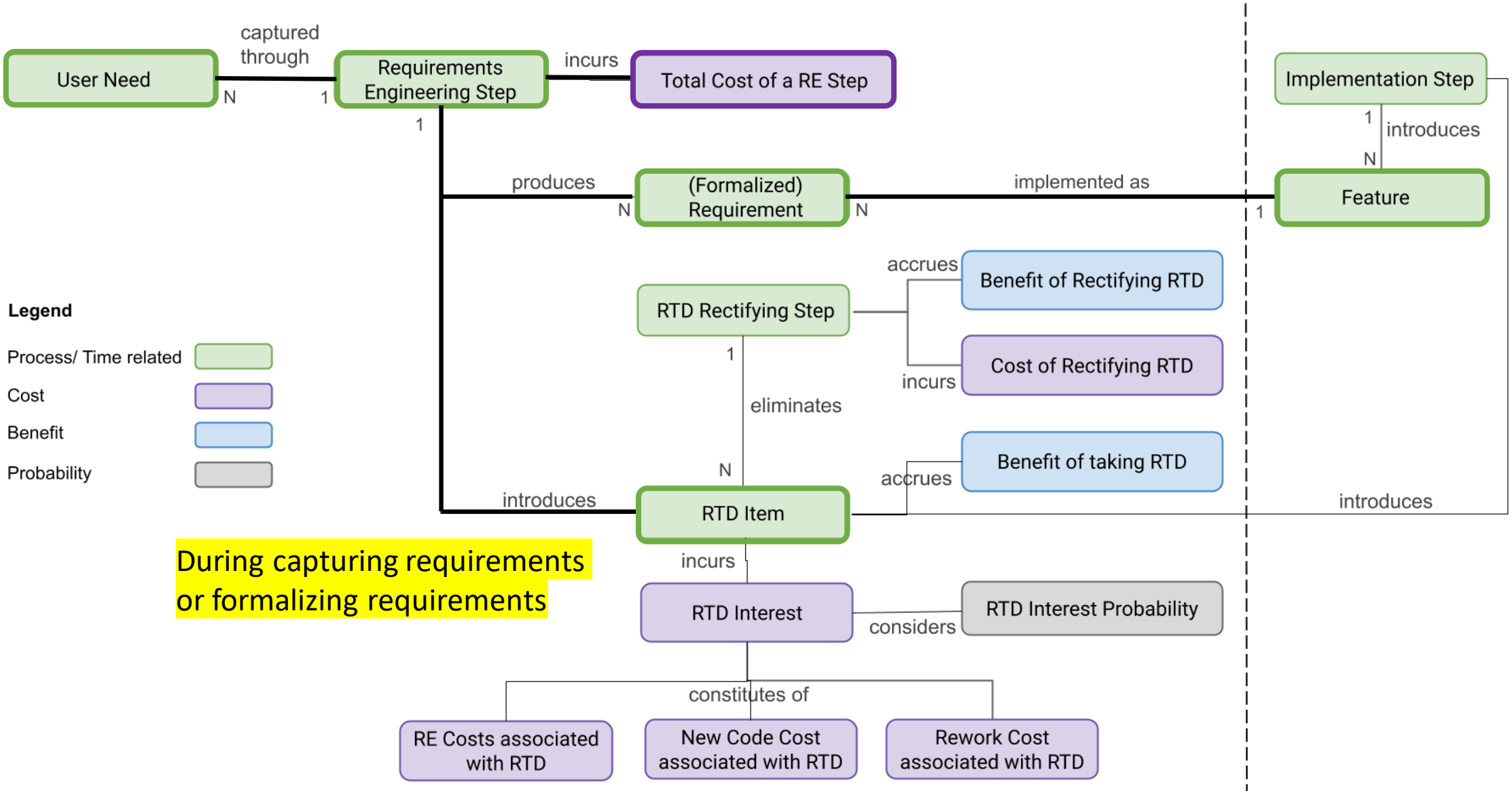

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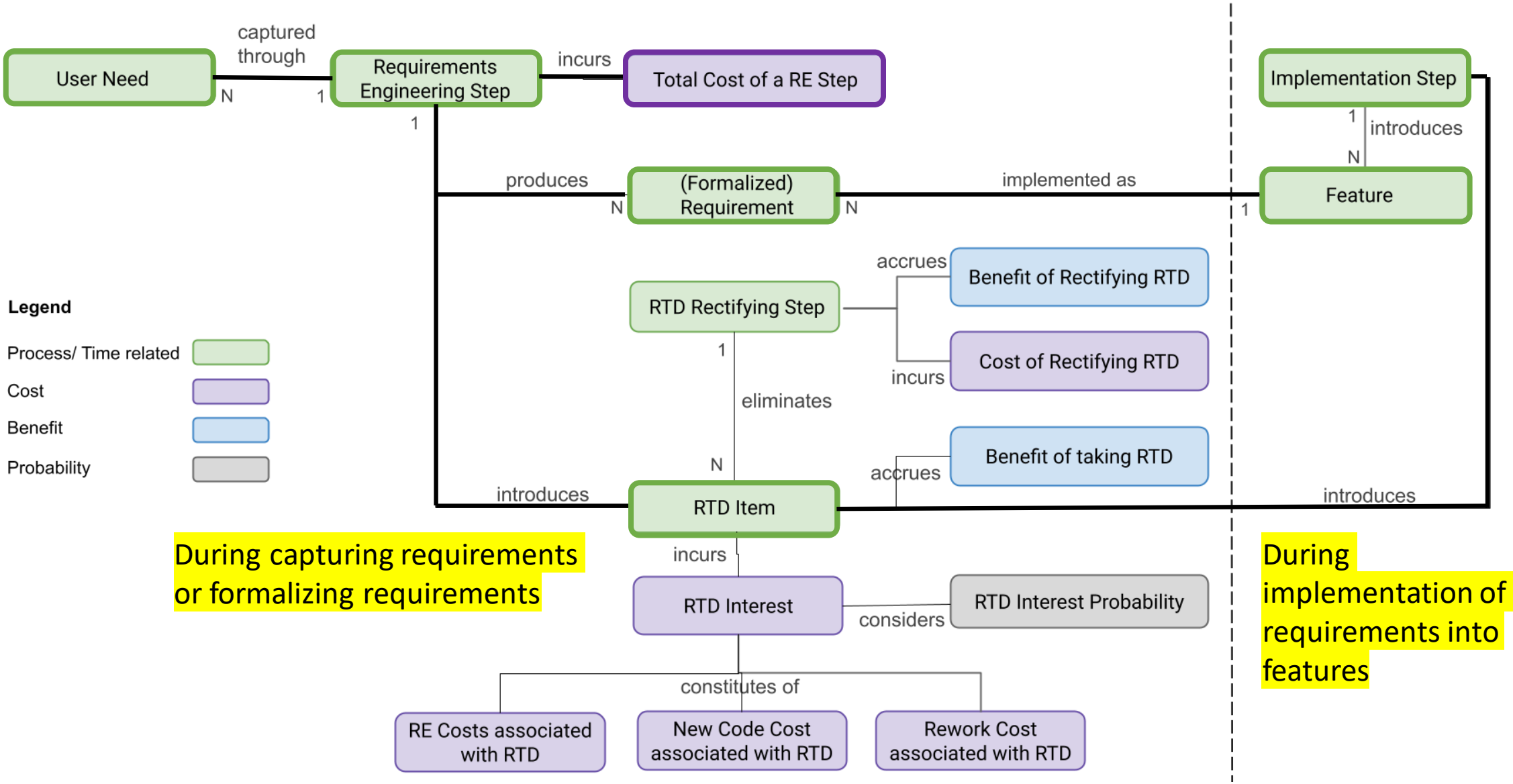

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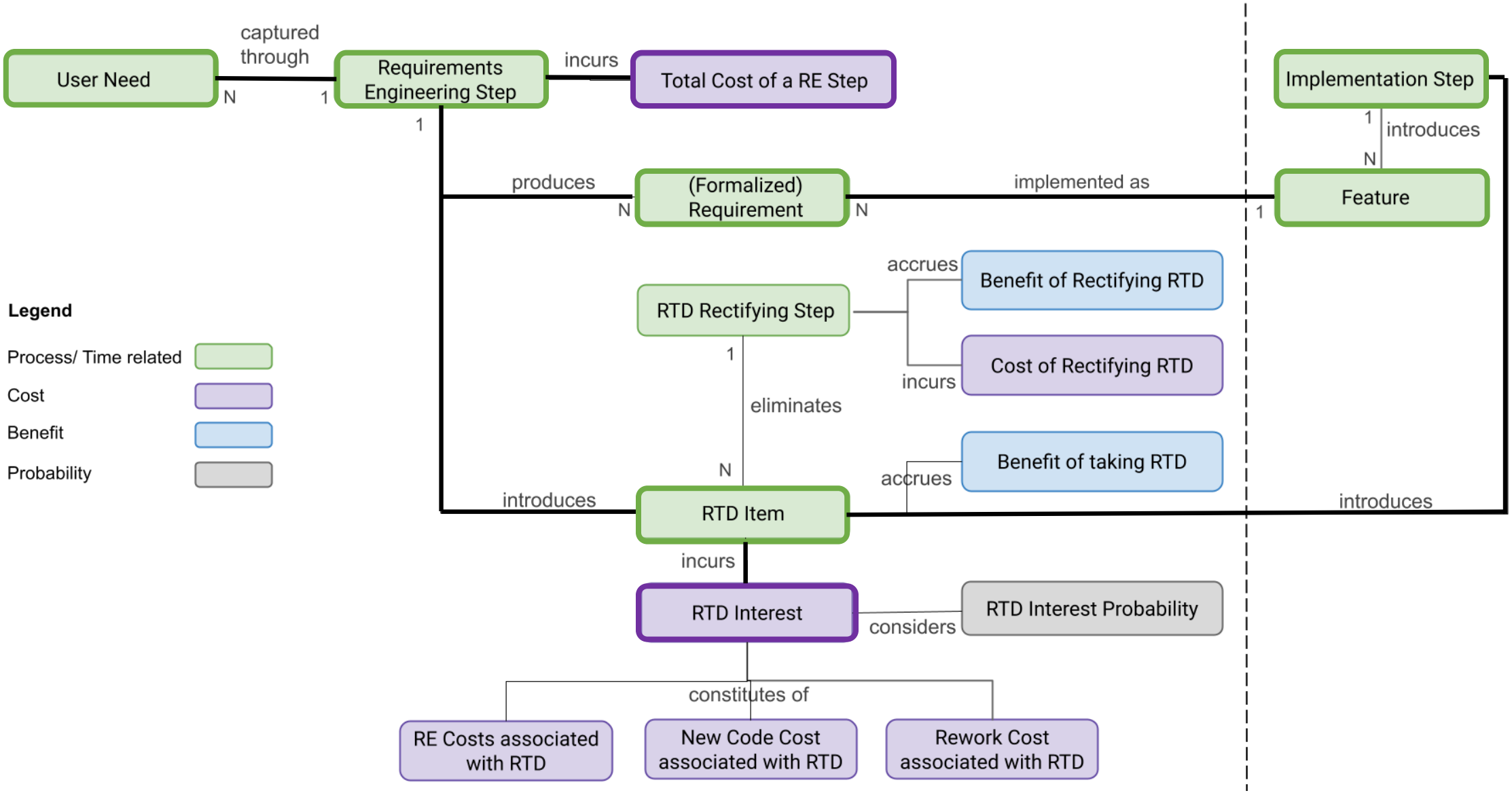

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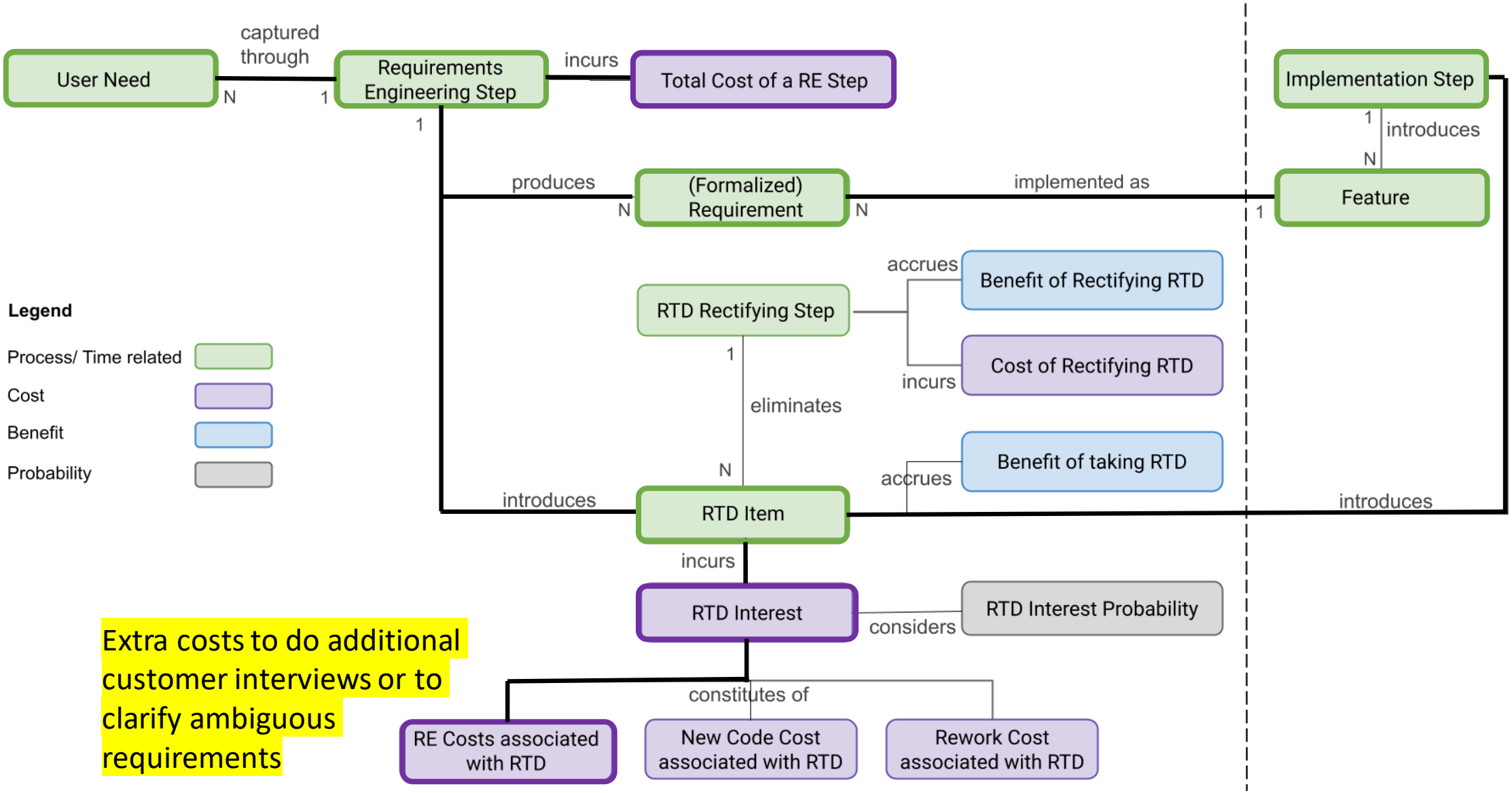
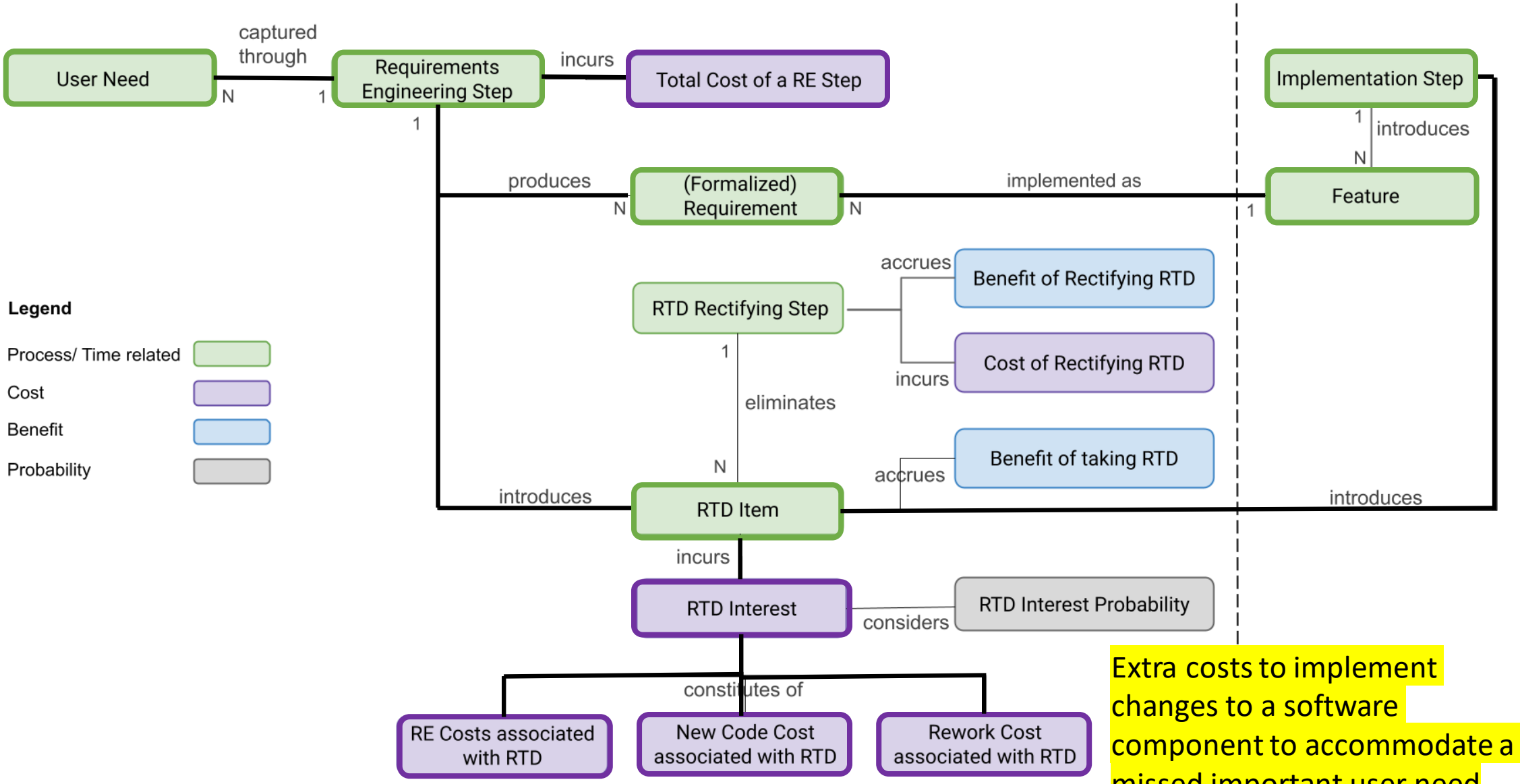


Extra costs to do additional customer interviews or to clarify ambiguous requirements

Results (Model development): RTD Quantification Model (RTDQM)



Extra costs to implement changes to a software component to accommodate a missed important user need

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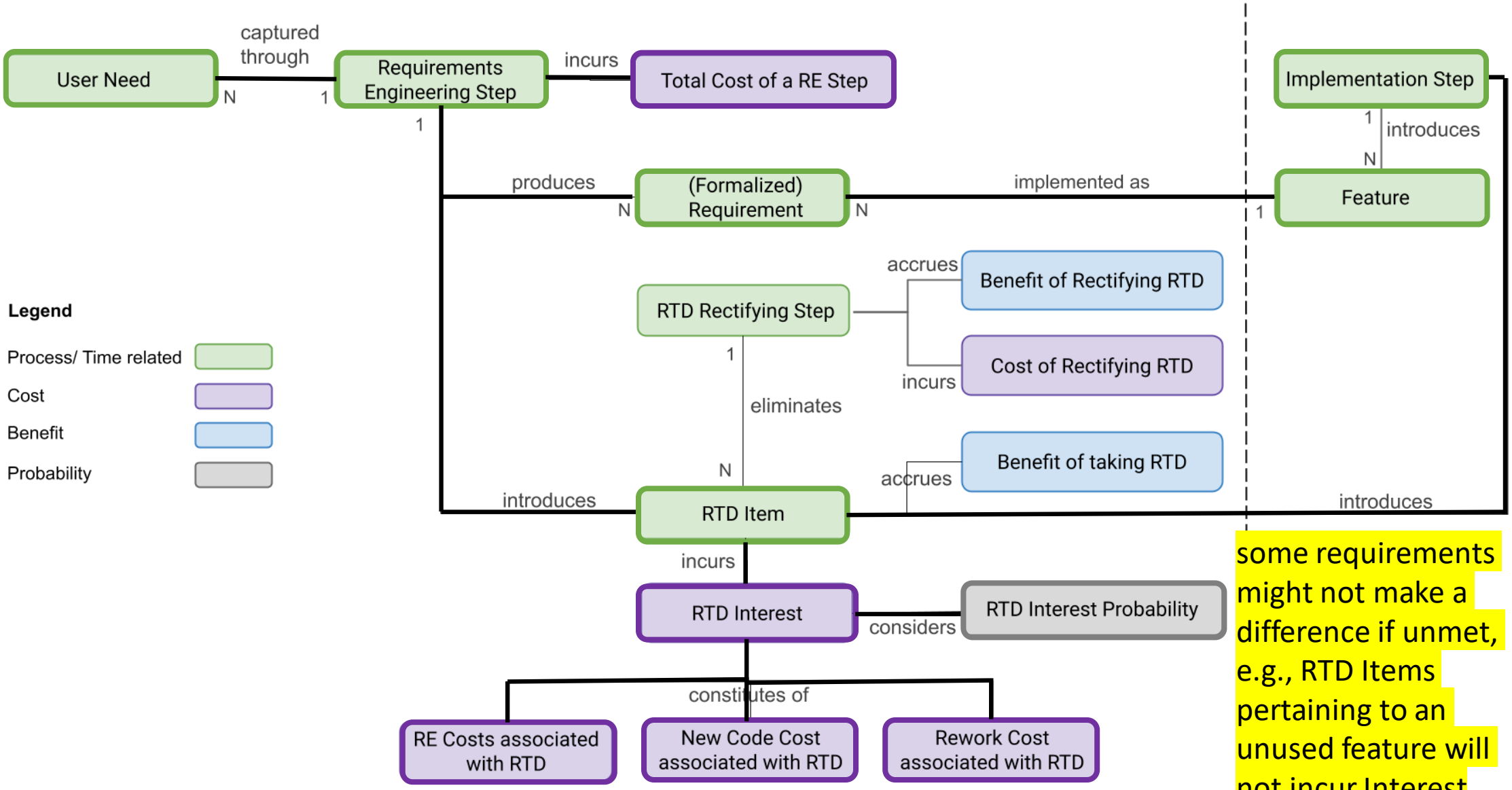
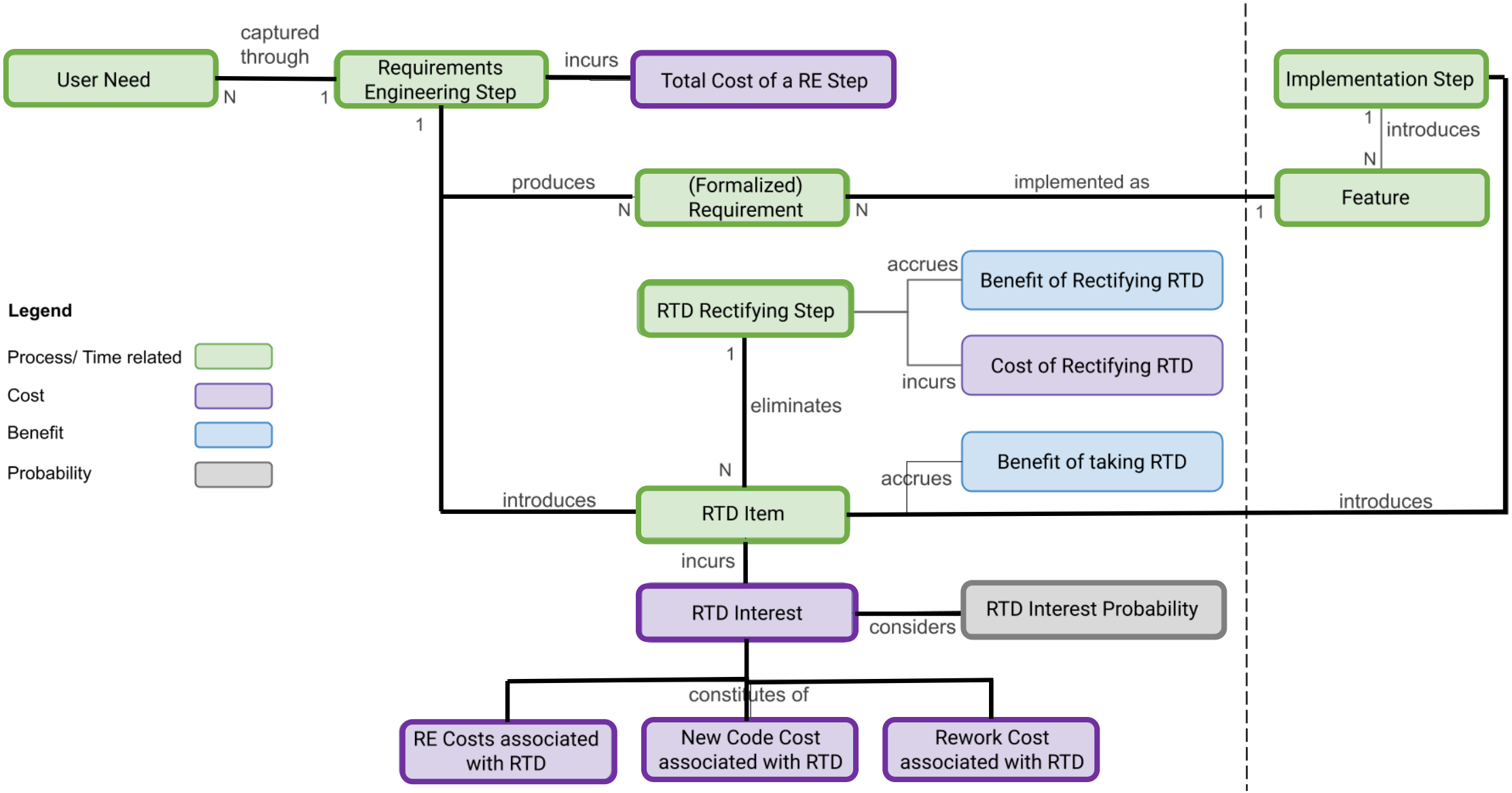


some requirements might not make a difference if unmet, e.g., RTD Items pertaining to an unused feature will not incur Interest

Results (Model development): RTD Quantification Model (RTDQM)



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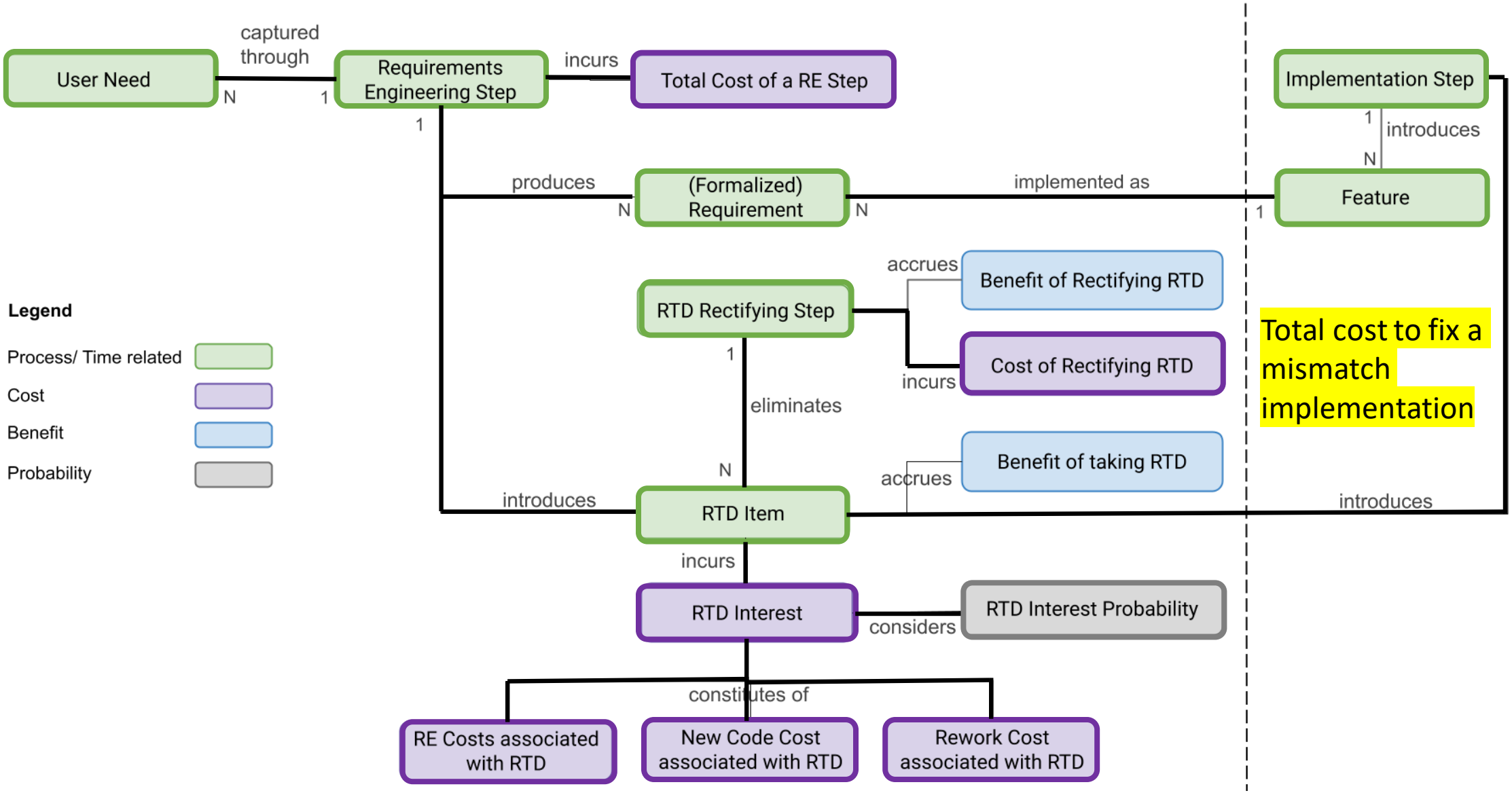

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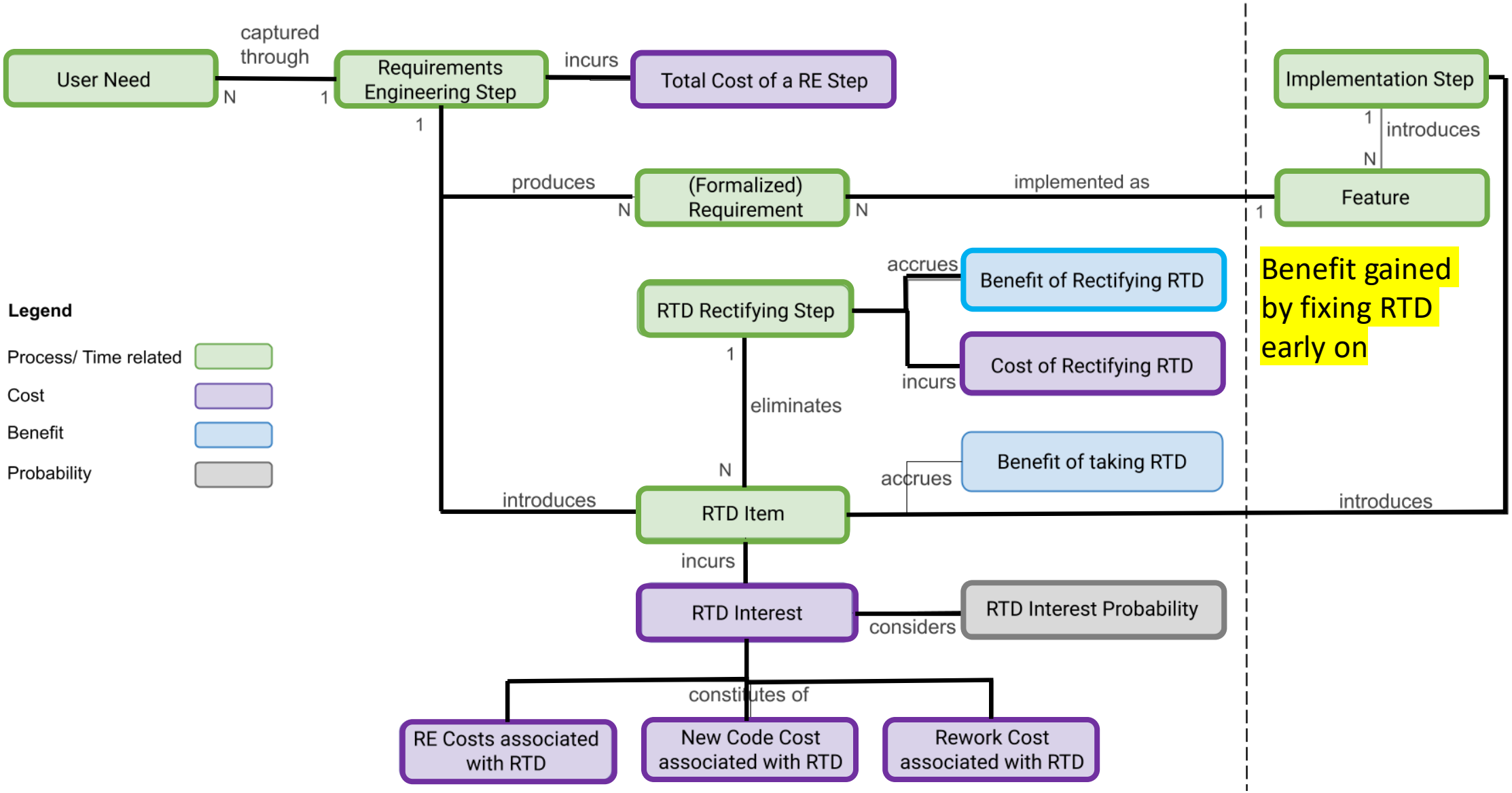

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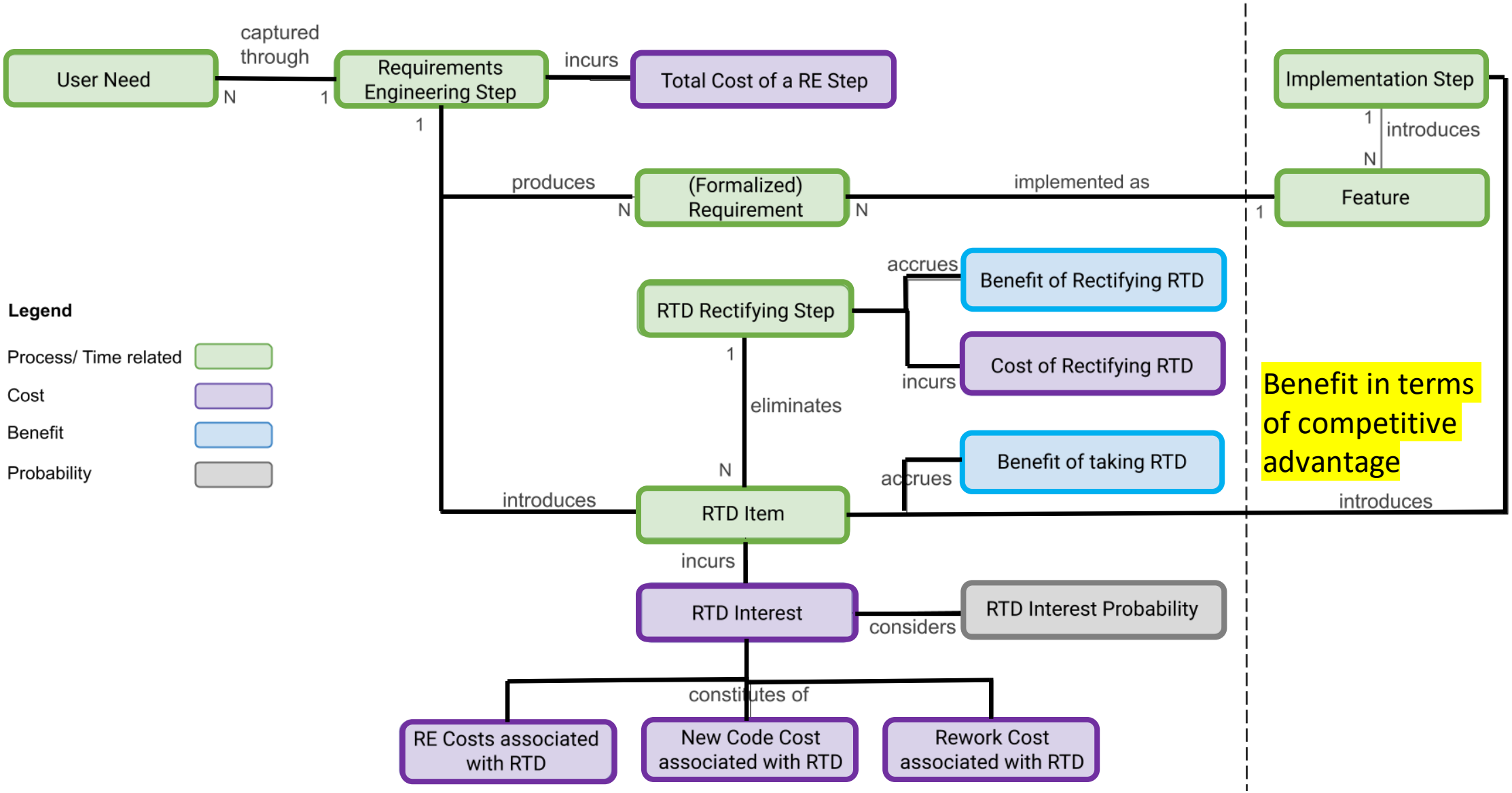

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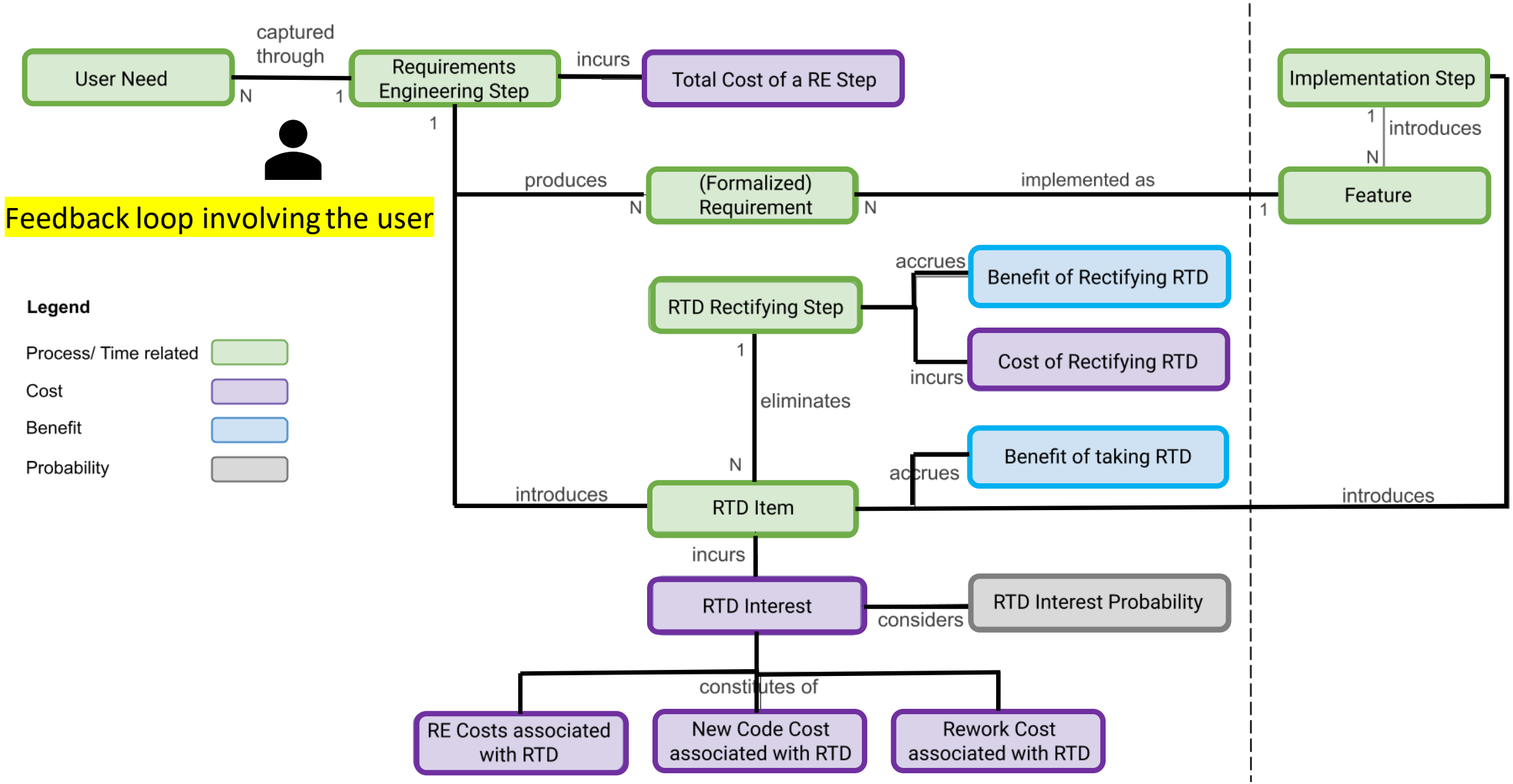

Results (Model development): Key Observations from the development of the conceptual model

- Although **RTD** is similar to code-related TD (i.e., Code TD, Design TD, Architecture TD) in some aspects, it also **has its own components**
- Different from code-related TD, RTD **has a feedback loop involving the user**
- **RTD Interest** can incur **extra costs associated with Requirements Engineering as well as Implementation**
- **RTD Items** can be introduced during Requirements Engineering or Implementation activities, regardless of the presence of code-related TD
- Similar to benefits accrued by refactoring code, **rectifying RTD can also accrue benefits**

DISCUSSION

Some thoughts for Discussion

- RTD applies for all types of software requirements. We are interested in understanding **how the equation might change for quantifying RTD for software requirements concerning veracity**

- **All software systems have veracity requirements, in most cases as a non-functional requirement** similar to `security' or `reliability'. An example is veracity of financial data in banking systems.

- **Some software systems may require specific veracity requirements to be met as functional requirements.** For example, an Organic Products Certification System may have specific veracity requirements related to the organic regulation to be implemented as functional requirements.

- What would be the impact of Requirements Technical Debt (RTD) **for software systems implementing software requirements concerning veracity** unless RTD is managed? Will stakeholders be convinced to manage RTD if **the interest *or the cascading impact, e.g., on software implementation or the customer,*** can be quantified?

Acknowledgements

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- ***The Veracity Spearhead team** for their valuable insights and support throughout*
- ***The University of Auckland***

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