

# Process Traceability-Systematic Review

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**Abstract:** Process traceability is the ability to verify the history, location, or application of a process by means of documented recorded identification. To be competitive in the business for any firm have to deliver good quality at low cost. To achieve this they have to manage their resources efficiently, reduce wastes and most importantly eliminate unnecessary delays. A good traceability mechanism ensures delay free operations in the product development or distribution cycle. Traceability is used to ensure that the right products are being built at each phase of the product development life cycle, to trace the progress of that development and to reduce the effort required to determine the impacts of requested changes. Traceability is one of the essential activities of good requirements management. Process traceability enables production managers to trace a requirement from its emergence to its fulfilment. This review unfolds number of common definitions, challenges, available tools and techniques about process traceability as described in some major studies on traceability.

**Keywords:** Process Traceability, Requirement Engineering, Systematic Review and Requirement Management.

## I.INTRODUCTION

The IEEE Standard Glossary of Software Engineering Terminology defines traceability as “the degree to which a relationship can be established between two or more products of the development process, especially products having a predecessor-successor or master-subordinate relationship to one another.”[IEEE-610] Traceability is used to track the relationship between each unique product-level requirement and its source. For example, a product requirement might trace from a business need, a user request, a business rule, an external interface specification, an industry standard or regulation, or to some other source.

This review explores the following broad aspects of traceability: 1) what is process traceability? 2) Why is process traceability a good practice? 3) How is traceability performed? 4) What are the key benefits of traceability? 5) What are the issues and challenges associated with process traceability implementation?

Process traceability, if effectively implemented can help organisations to fulfil its customer’s requirement in more effective way and also optimises the resources by eliminating unwanted operations. Many personalities have contributed in traceability concepts, best practice, implementation, enhancement and improvements. Some of the key contributions are emphasized in this review study as follows.

## II.SYSTEMATIC REVIEW

Traceability is the ability to discover the history of every feature of a system so that the impacts of changes in requirements can be identified **Hamilton et. al**[1]. **Edwards et. al**[2] define traceability as a technique used to provide a relationship between the requirements, the design, and the final implementation of the system. **Palmer et. al** [3] states that traceability gives essential assistance in understanding the relationships that exist within and across process requirements, design, and implementation. These relationships allow designers to show that the design meets the requirements and help early recognition of those requirements not satisfied by the design. Palmer states that traceability helps ascertain how and why system development products satisfy stakeholder requirements.

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According to **(Rosa Candida Pinto, Carla Silva and Jaelson Castro)** process traceability is achieved through requirements specifications, system architecture models, static and dynamic software design models and implementation artefacts of agent-oriented process systems. Their work describes the process that can be used to extend tropos to support traceability. A process to the following tropos phases includes three stages as follows: Information Gathering (IG), Information Structuring (ST) and Definition of the Traceability Matrixes (TM). According to **(BjörnKvarnström)** traceability plays vital role in continuous process and can be implemented by using the methods as such physical lot-integrity, lot-mismatching, lot-end-mixing and lot-sequence mixing. Traceability links are needed to connect design and implementation elements as well. To be useful, traceability links have to be defined at a fine-grained level and maintained in a correct and complete state **(Patrick Maeder, Ilka Philippow and Matthias Riebisch)**.

Radio-frequency identification (RFID) technology provides an effective tool for managing traceability. This is because it allows automatic digital registration of data, and therefore reduces errors and enables the availability of information on demand. A complete traceability system can be developed in the production sector by joining this technology with the use of wireless sensor networks **(Eva Rajo-Iglesias)**. According to **(Sommerville and Sawyer)** requirements engineering involves activities for discovering, documenting and maintaining a set of requirements for a system. Requirements engineering (RE) activities are often divided into five categories: Requirement elicitation, requirement analysis, requirement specification, requirement validation and requirements management. **(Gotel and Finkelstein)** define requirements traceability (RT) as “the ability to describe and follow the life of a requirement in both forwards and backwards direction (i.e. from its origins, through its development and specification to its, subsequent deployment and use, and through periods of on-going refinement and iteration in any of these phases).”

The definition of RT by **(Gotel and Finkelstein)** is considered to be a comprehensive definition and is cited by several researchers and the same definition is also quoted at the Software Engineering Institute’s website (SEI 2008). According to **(Gotel and Finkelstein)** there are two aspects of RT: Pre- and post-RS traceability. Pre-RS traceability is concerned with those aspects of a requirement’s life from the point before it is included in the software requirements specification (SRS) **(Aurum and Wohlin)**. In pre-RS traceability, requirements are related to their origin and other requirements. The origin of requirements includes stakeholders, business rules or previous documents. Post-RS traceability, on the other hand, is concerned with those aspects of a requirement’s life from the point after it is included in the SRS **(Aurum and Wohlin)**. Post-RS traceability ensures that all requirements are fulfilled. In post-RS traceability, requirements are often related to test cases that ensure that software items satisfy the requirements. Beside these two aspects of RT others have classified traceability into the following four types **(Sommerville and Kotonya)**:

- Backward-from traceability: Links requirements to their sources which are in e.g. other documents.
- Forward-from traceability: Links requirements to the design and implementation components.
- Backward-to traceability: Links design and implementation components back to the requirements.
- Forward-to traceability: Links other documents to relevant requirements, e.g. operation manuals describing the system functionality.

### III.BENEFITS OF TRACEABILITY

Traceability helps in identifying the sources of the requirement whether performed by a person or document or group of persons [4].

1. Traceability helps in performing impact analysis, which traces to what other component(s) might be affected in response to change in a particular requirement.
2. Traceability helps in test case verification, e.g. which test cases verify a certain requirements [6].
3. Traceability assists in tracking the overall progress of the project, e.g. one can measure how many requirements are implemented, how many are still in the design phase and how many are completed.
4. Requirements are many times interdependent on each other and on other artefacts; traceability provides relationship between them [9].

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## IV. CHALLENGES AND ISSUES ASSOCIATED WITH TRACEABILITY PRACTICE

Some of the key challenges are:

- Cost of RT, efforts, resources related with traceability implementation [5].
- Lack of coordination between team members, developers think that traceability costs more than it delivers [5].
- Level of traceability to be implemented [5].
- Requirement changed by users and availability of less contextual information in decision making [12].

The key issues associated with traceability practices are shown in the following table.

Table 1

Reference	Issues Identified in Review
Arkley and Riddle[10]	Traceability does not offer immediate benefit to development process.
Cleland Huang[13]	Not easy to manage if excessively implemented.
Ramesh[6]	Organisational, environmental and regulatory factors.
Cleland-Huang[14]	Insufficient resources, time, cost for traceability. Failure to follow standards.

## V. COMPARISON OF TRACEABILITY TOOLS

The following table provides the comparison between of process traceability tools found in the review study along with their description and type.

Table 2

Tools	Description	Type
DOORS	Used to trace, capture, link and manage changes to requirement.	Requirement management tool that supports traceability.
TRAM	Manages system requirement.	Supports traceability between systems
RETRO	Automatic generation of requirements.	Traceability tool.
DesignTrack	Traceability between requirements.	Requirement management tool that supports process requirement traceability.
Scenario advisor tool	Traceability between scenario models and requirements.	Helps in writing scenario also supports traceability.

## V. LITERATURE GAP

Though the literature survey reflects the key contributions made on traceability concepts, methodology, tools and techniques and best practices. But questions to be answered or can be addressed with the available data are how contextual data information between traceability systems are gathered effectively. Further a framework to choose right level of traceability as guidelines would resolve conflicts highly. Never the less traceability in requirement engineering has lot to motivate research work in near future.

## VI. CONCLUSION

Process traceability, if effectively implemented can help organisations to fulfil its customer's requirement in more effective way and also optimises the resources by eliminating unwanted operations. . Traceability is used to ensure that the right products are being built at each phase of the production process, to trace the progress of that development and to reduce the effort required to determine the impacts of requested changes. It is critical to consider right level of traceability and cop up with various factors (cost, time, efforts, organisational, technical and environmental) associated

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with it to ensure its successful implementation. It is obvious that traceability is a good practice that will benefit more on effective implementation. Further on effective implementation of process traceability mechanism the target (required) process, location and/or history can be tracked without any significant delay

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