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A Brief Discussion on Requirements Analysis

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ABSTRACT:

In order to guarantee effective system development, requirements analysis is a crucial stage in the system engineering process that focuses on comprehending, recording, and managing the needs and expectations of stakeholders. The main points and importance of requirements analysis in system engineering are summarised in this abstract. In order to specify the intended system behaviour and features, requirements analysis is introduced as a systematic method of collecting, analysing, and prioritising needs in the abstract. In order to enable efficient system design, development, and deployment, it emphasises the need of extensive requirements analysis. The basic goals of requirements analysis are also covered in the abstract, including stakeholder identification, requirement elicitation and documentation, dispute resolution, and requirement traceability and verifiability. It emphasises the importance of requirements analysis in ensuring that the system complies with user requirements, legal requirements, and practical limitations.

KEYWORDS:

Change Management, Design Requirements, Elicitation, Traceability Matrix.

I. INTRODUCTION

The process of system engineering that focuses on comprehending, capturing, and documenting the needs and expectations of stakeholders is known as requirements analysis. Eliciting, analysing, and defining the criteria that a system must achieve to fulfil its intended purpose entails a methodical and iterative methodology. Establishing a precise and thorough grasp of what the system should achieve, how it should act, and the limitations it must adhere to are the objectives of requirements analysis in system engineering. Through this process, it is ensured that the system's conception, design, and execution are in line with stakeholders' expectations and desired results [1], [2]. The following essential tasks are often part of requirements analysis:

Elicitation: To gather requirements, stakeholders must be consulted in order to ascertain their needs, objectives, and expectations. To acquire pertinent information, this may include holding workshops, questionnaires, interviews, and other methods. Understanding the operating environment, user requirements, performance standards, and any limitations or restrictions that need to be taken into account are the main points of emphasis [3], [4].

Analysis: Analysis is necessary to determine the relevance, interdependencies, and possible conflicts of the needs once they have been elicited. To evaluate the viability, completeness, and consistency of the requirements, analytical methods including requirements prioritisation, traceability analysis, and impact analysis are used.

Documentation: The discovered needs are then succinctly, precisely, and logically described. All stakeholders, including system designers, developers, testers, and project managers, may use this material as a reference. To successfully capture and express the needs, a variety of artefacts, including requirements papers, use cases, user stories, and system specifications, may be utilized [5], [6].

Validation and Verification: A crucial step in ensuring that requirements are accurate, consistent, and in line with stakeholder demands is to validate and verify them. This includes formal evaluations, formal reviews with stakeholders, and validation efforts to ensure that the requirements accurately reflect the intentions and expectations of the stakeholders.

Change management: Throughout the system engineering process, requirements are liable to change. To accommodate changing needs, a strong change management procedure should be in place. This entails recording and analysing proposed modifications, assessing their effect on the system, and putting authorised changes into practice in a controlled way.

A system engineering project's success depends on a successful requirements analysis. It offers a strong basis for system design, development, and implementation, assisting in risk management, cutting down on redundancy, and raising stakeholder satisfaction. System engineers may make sure that the finished system satisfies stakeholder demands, operates as intended, and produces the required results by properly understanding and specifying requirements.

II. DISCUSSION

Inputs to The Systems Engineering Process

The needs of the client and the restrictions of the project are inputs to the procedure. The performance characteristics of the system being created are closely related to requirements. They relate to how effectively the system will function in its intended context and are the system's declared life-cycle customer demands and goals. Limitations imposed by external interfaces, project support, technology, or life cycle support systems are known as constraints. The design possibilities available to the development teams were constrained. Because the main goal of the systems engineering process is to translate requirements into designs, requirements are the main emphasis of the process. These designs are created within the limitations of the method. At some point, it must be confirmed that they adhere to the criteria and limits [7], [8].

Types of Requirements

There are several categories for requirements. The following are typical divisions of technical management need categories:

Customer specifications: statements of reality and presumptions that specify what the system is expected to do in terms of the mission's goals, the environment, the available resources, and the measurements of effectiveness and suitability (MOE/MOS). The eight fundamental tasks of systems engineering are performed by the customers, with the operator serving as the principal client. Operational requirements will specify the fundamental need and, at the very least, respond to the inquiries raised in Figure 1.

Functional Requirements: The essential duty, deed, or action that must be performed. The top-level functions for functional analysis will be the functional (what needs to be done) requirements found in the requirements analysis.

Performance Requirements: The level of a task's execution required; often expressed in terms of quantity, quality, coverage, timeliness, or preparedness. Performance requirements (how well must it be done) will be developed collaboratively across all identified functions based on system life cycle factors. These requirements will be characterised in terms of the degree of certainty in their estimate, the degree of criticality to the success of the system, and their relationship to other requirements [9], [10].

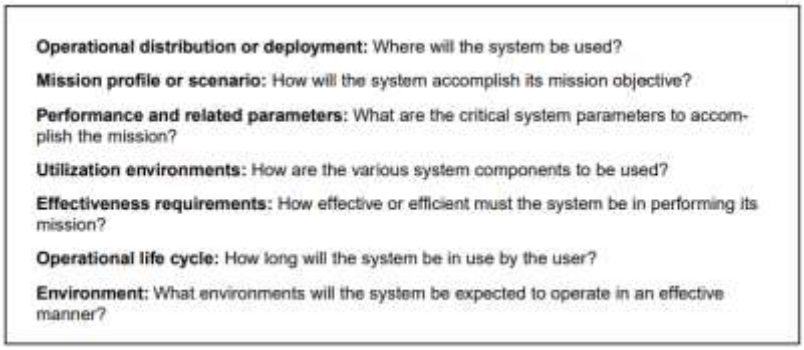

Figure 1: Operational Requirements Basic Questions.

Design requirements: These requirements are stated in technical data packages and technical manuals as "build to," "code to," and "buy to" requirements for goods and "how to execute" requirements for processes. Requirements that are inferred by or changed as a result of higher-level requirements are known as derived requirements. For instance, a demand for extended range or fast speed could lead to a necessity for minimal weight in the design. A need that is created by splitting or otherwise assigning a high-level requirement into many lower-level requirements is known as an allocated requirement. The weight requirements for the two lower-level components of a 100-pound item made up of two subsystems can be 70 pounds and 30 pounds, respectively.

Qualities of Effective Requirements

The following are qualities of excellent requirements:

1. A requirement has to be feasible. It must represent a need or goal for which a technological solution is feasible at prices deemed reasonable.
2. It has to be verifiable, which means it can't be described by terms like "excessive," "sufficient," "resistant," etc. The predicted performance and functional usefulness must be articulated in a way that makes objective, preferably quantitative, verification possible.
3. A demand should be clear. There can only be one potential interpretation.
4. It must be comprehensive and include all mission profiles, operational and maintenance ideas, use settings, and restrictions. The customer's demand must be understood and all relevant information must be available.
5. It must be stated in terms of need rather than solution; in other words, it must address the "why" and "what" of the need rather than how to meet it.
6. It has to be in line with other specifications.
7. Conflicts must be settled at the beginning.
8. It must be suitable for the hierarchy level of the system. It shouldn't be so intricate that it limits options for the degree of design that is currently being used. For instance, a system-level specification would not typically include particular requirements pertaining to components.

Relevant Requirements Analysis

In order to define the requirements for system functions, requirements analysis include articulating customer demands and goals in the context of intended customer usage, surroundings, and identifiable system features. The mission and environment definitions are updated and revised in order to support system definition.

To optimise performance requirements for identified functions and confirm that synthesised solutions can fulfil client needs, requirements analysis is carried out iteratively alongside functional analysis. Requirements analysis is used to: Clarify customer objectives and requirements; Identify and define constraints that restrict solutions; and Specify functional and performance requirements based on effectiveness metrics provided by the customer.

Generally speaking, requirements analysis should provide a knowledge of:

1. **Features:** What the system must do,
2. **Performance:** How successfully the tasks must be carried out,
3. **Interfaces:** The setting in which the system will operate, as well as other conditions and limitations.

The understandings gained through requirements analysis provide the groundwork for the subsequent functional and physical designs. Successful design definition depends on good requirements analysis.

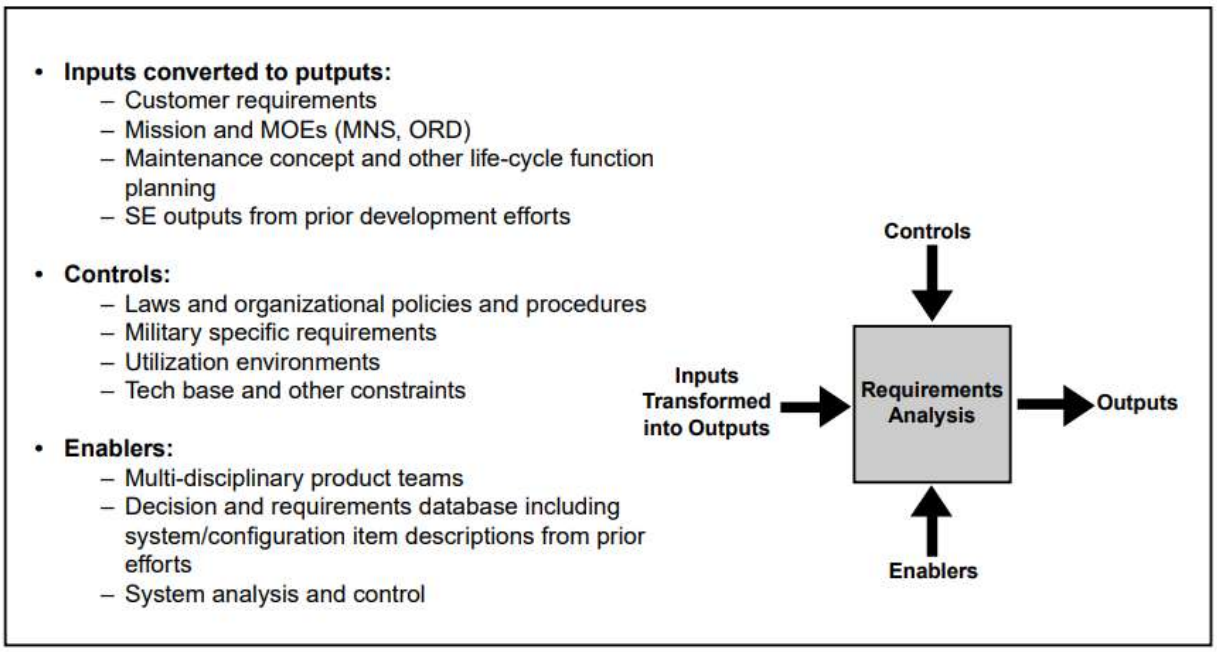

Figure 2: Inputs to Requirements Analysis.

Inputs

Customer goals and objectives, missions, MOE/MOS, environments, key performance parameters (KPPs), technological basis, output requirements from earlier SEP application, programme decision requirements, and suitability criteria are examples of typical inputs. (For further ideas, see Figure 2.) For both system products and system processes including development, manufacture, verification, deployment, operations, support, training, and disposal (eight core functions), input requirements must be thorough and well-defined.

Role of Integrated Teams

The operator customers are knowledgeable about using the product or thing being created operationally. The government and contractor who are developing the system may not have the necessary operating expertise. The operator's demand is often neither fully nor clearly defined in a form that developers can use. Developers are unlikely to be given a well-defined issue from which to create the system specification. Teamwork is thus required to comprehend the issue and assess the requirement. Customer participation in the definition team is essential.

Contrarily, consumers often find it simpler to explain a system that makes an effort to remedy the issue than to describe the issue itself. The best answer is produced by a comprehensive technical development effort that appropriately balances the numerous client mission goals, functionalities, MOE/MOS, and restrictions, even though these "solutions" may be somewhat practical. The examination of requirements will be balanced by an integrated approach to product and process development that offers comprehension and accommodation for the eight key functions.

Requirements Analysis Outputs

Requirements analysis produces requirements that are often presented from one of three viewpoints. The terms operational, functional, and physical perspectives have been used to refer to them. To completely comprehend the demands and goals of the consumers, all three are required and must be integrated. In the decision database, each of the three is described.

The requirements analysis process in system engineering results in a number of significant outputs that form the cornerstone of system design, development, and implementation. These products provide clarity, traceability, and alignment with stakeholder requirements by capturing the specified requirements in an organised and recorded way. The requirements document is the main artefact used to outline and record the requirements. It offers a thorough overview of the system's functional and non-functional needs, as well as the capabilities, behaviours, performance standards, restrictions, and interfaces of the system. The system engineering process's many stakeholders may turn to the requirements document for guidance.

Use cases or user stories explain the behaviour of the system from the viewpoint of users or other actors engaging with it. They provide specific illustrations of how the system should react to certain user actions or situations. Use cases and user stories provide a foundation for system design and testing and aid in understanding the functioning of the system. System specifications include thorough explanations of the aspects of the system, such as its physical, functional, and performance characteristics. Technical requirements, interface requirements, operational requirements, and any applicable standards or laws that the system must abide by may all be included in these specifications. System design, development, and integration processes are guided by system specifications.

A traceability matrix explains how requirements may be followed throughout the system engineering process. It relates the stated requirements to design components, test cases, and other system artefacts by mapping them to their sources, such as stakeholder demands or legislation. The traceability matrix guarantees that each criterion is appropriately handled and offers a way to check the system's consistency and completeness. During the requirements analysis, the discovered needs are given a priority rating based on their significance and influence on the functionality and performance of the system. During the system design and development process, prioritisation aids in resource allocation, decision-making, and trade-off analysis.

Documenting Change Management: In order to handle changing needs, requirements analysis also entails setting up a change management procedure. Procedures, forms, and instructions for gathering, evaluating, and putting into practise suggested modifications to the requirements are included in the change management documentation. The system engineering process is efficiently regulated, analysed, and shared thanks to this documentation. These results of the requirements analysis provide a concise and organised representation of the system's needs, which serve as a roadmap for the system's design, development, and implementation phases. They aid in

communication, act as a resource for stakeholders, and guarantee that the resultant system satisfies their requirements and expectations.

III. CONCLUSION

Finally, requirements analysis is an essential phase in the system engineering process that guarantees a precise comprehension of stakeholder demands and lays the groundwork for effective system development. Organisations may reap a number of significant advantages by carefully examining and recording requirements. The cornerstone for efficient communication and teamwork between many stakeholders, such as system engineers, designers, developers, and end users, is requirements analysis. Effective communication is made possible by clear and well-defined requirements, ensuring that all stakeholders are aware of the goals and expectations of the system.

Furthermore, requirements analysis provide a foundation for system assessment and verification. The creation of test plans and verification methods is made easier by the use of well stated requirements as a standard against which the system's functionality and performance can be evaluated. Finally, controlling project risks depends greatly on requirements analysis. Organisations may detect and manage possible risks and obstacles early in the development process by precisely specifying and analysing requirements. This makes it possible to use proactive risk mitigation methods and makes it more likely that the system will provide the required results within the limitations of time and money.

In the end, requirements analysis is a crucial stage in system engineering that enables businesses to develop a clear understanding of stakeholder needs, spot potential conflicts or gaps, choose wisely between trade-offs, promote communication and collaboration, and control project risks. Organisations may build the groundwork for effective system development and produce systems that live up to stakeholder expectations and provide desired results by conducting in-depth requirements analyses.

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