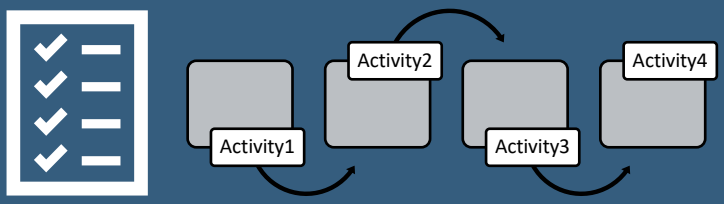

TDM GUIDELINES

Support for **T**echnical **D**ebt **M**anagement in Software Projects

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PROPOSAL:
What to consider when managing **T**echnical **D**ebt items

FOCUS:
Software Development Teams

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ABOUT THE TDM GUIDELINES

Research Context

The current evidence-based Guidelines were structured in the context of a doctoral research in the Experimental Software Engineering Group (ESE) of the Systems Engineering and Computer Science Department (PESC/COPPE) at the Federal University of Rio de Janeiro. These guidelines comprise information from the technical literature and the software industry.

The Proposal

Main Goal

It refers to guidelines to support teams in managing TD items. These guidelines are structured in parts that can be adopted by team members, such as macro activities and practical actions (i.e., activities, tasks, and recommendations to perform such actions). It also includes advice on some artifacts and technologies that can be adopted to support the performing of the practical actions.
It is expected that software organizations can use these TDM Guidelines as a strategy to anticipate possible risks associated with the maintenance and evolution of their software products.

Context

Technical Debt (TD) is a metaphor associated with technical decisions taken in the software development concerning internal quality software issues. Many decisions must be taken when a project software starts, but it is hard for the team to have a complete understanding of the problem as a whole, which turns inevitable the incurrence of unintentional TD. On the other hand, TD may be intentionally incurred to achieve some business advantages by sacrificing the internal quality in the short-term, like savings of time (schedule) and cost reduction. In the long-term, TD items may carry some risks to internal software quality, hindering the evolution of software products. Thus, TD can influence positively or negatively to the software project ecosystem and the quality of their software products. Then, TD is not necessarily a "bad thing" if it is perceived and managed strategically in the software project.

STRUCTURE OF THE TDM GUIDELINES

Main Elements

The structure of the TDM Guidelines combines phases, TD macro activities, and practical actions (i.e., activities, tasks, and recommendations). These guidelines also provide some artifacts as well as information about technologies that can be adopted by team members to deal with TD items.

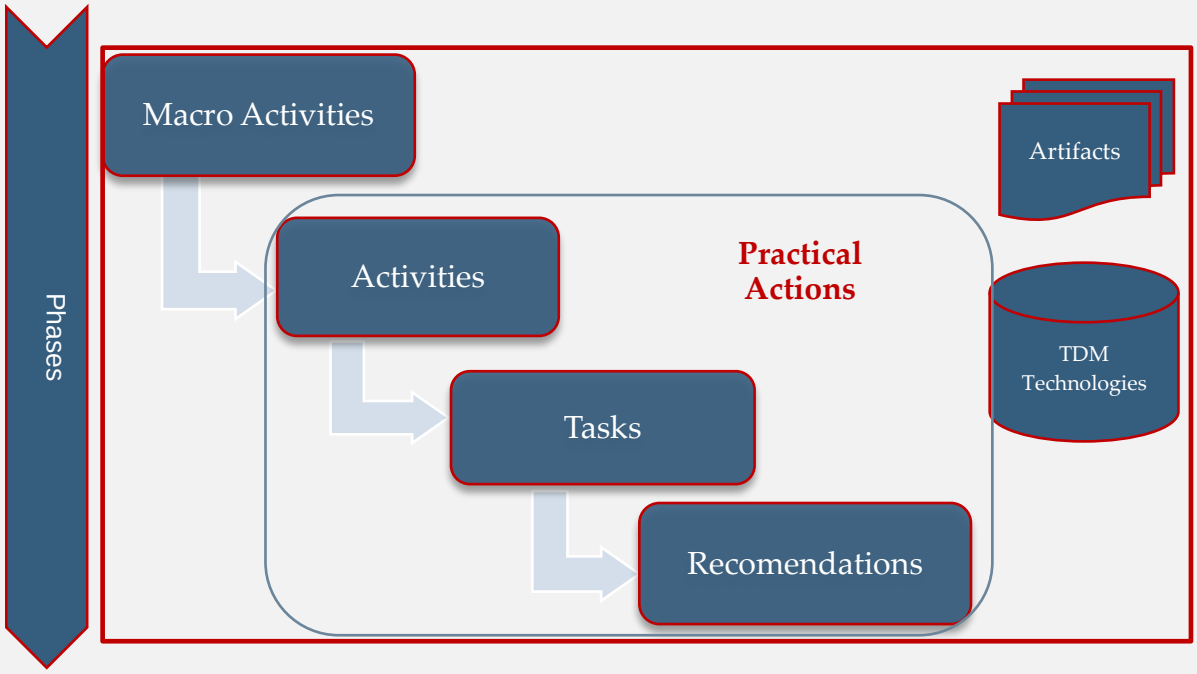


Figure 1. TDM Guidelines Structure

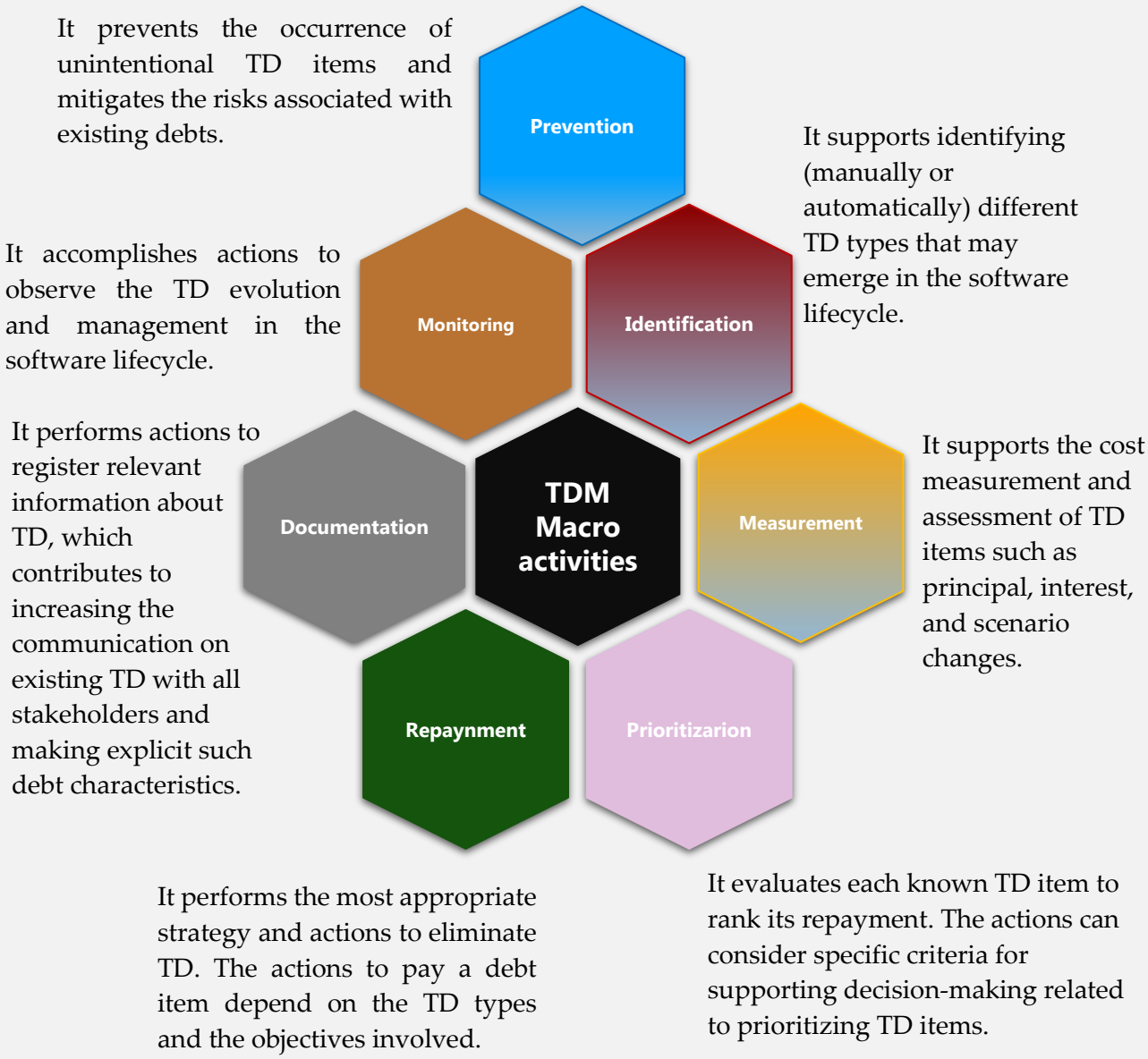
Phases

The phases organize the performing of practical actions to deal with TD items over time. These are associated with generic moments concerning to planning, development, and evolution of software products.

- **Planning Iterations/Milestones:** The practical actions related to the planning of TD management should be performed in the planning stages of the project, such as at the beginning of the project, during sprint planning meetings, and during sprint reviews/retrospectives.
- **Development and Evolution Iterations:** Other practical actions to deal with TD items should be performed iteratively, following the project cycles, through the development and evolution iterations of the software product.

Macro Activities for TD Management

The Practical Actions to deal with TD in software projects can be organized into macro activities. These essential macro activities are summarized in the figure illustrated below.



Practical Actions

Each macro activity comprises a set of practical actions that should be performed to deal with TD items aiming to minimize the risks related to internal quality software.

These practical actions refer to **Activities**, **Tasks**, and **Recommendations** that can be performed iteratively, following the project cycles.

Artifacts

The TDM Guidelines suggest artifacts and instruments that can be adopted by team members when performing the **Activities**, **Tasks**, and **Recommendations**. The main artifacts and instruments are:

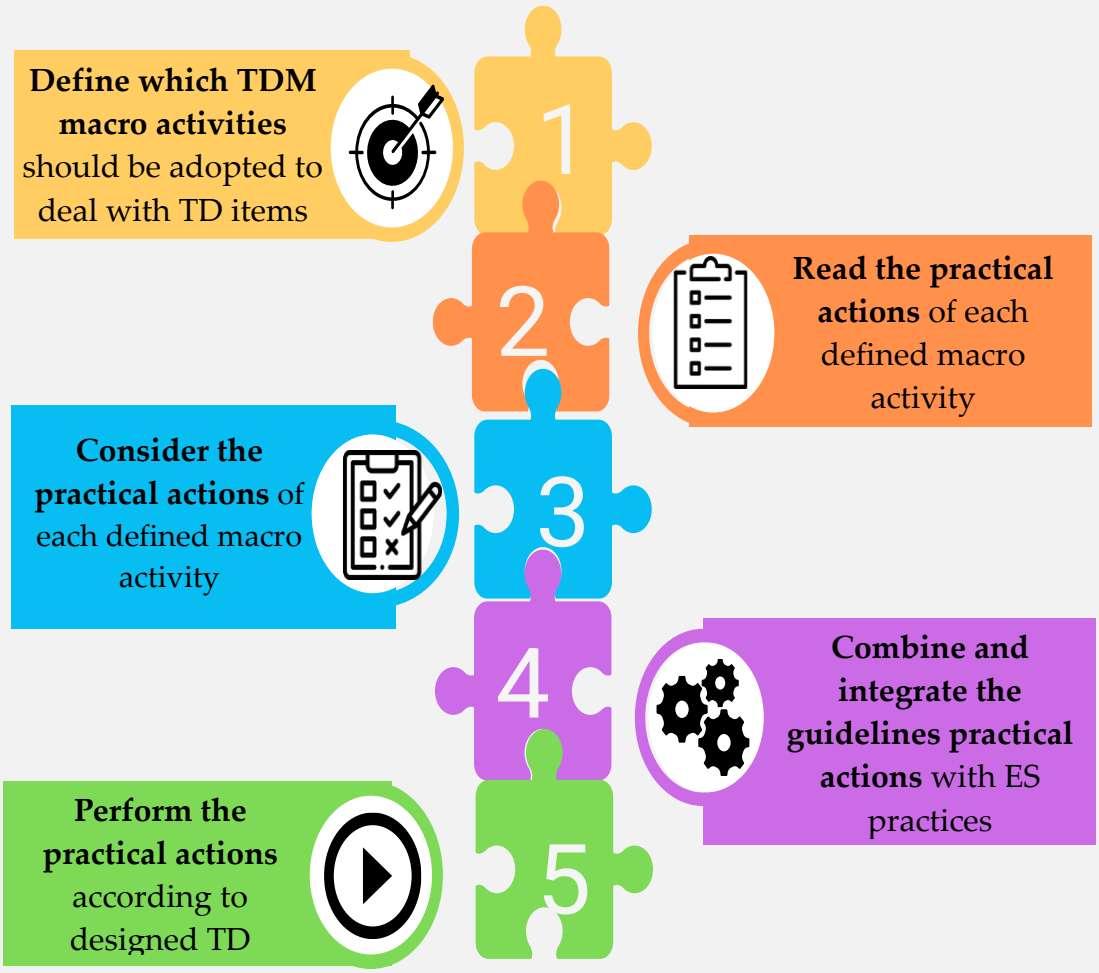
- A1- Questionnaire for mapping actions related to internal software quality: it supports the teams in mapping the useful actions, artifacts, and technologies that should be adopted in the planning and performing project phases to maintain and evolve software products.
- A2- List of Required Actions and Technologies Mapped (Potential TD items): it can be used to support identifying TD items from the required actions, technologies, and criteria.
- A3- Checklist to inspect TD items: it drives team members in the identification of different TD types.
- A4- TD Management Worksheet: it supports monitoring the existing TD items.
- A5-Template for TD documentation: it supports documenting relevant information about TD items.

TDM Technologies

The TDM Guidelines also offer indications of technologies (i.e., strategies, methods, SE practices, and tools) that can be used to perform the practical actions to manage TD. Each technology provides support to specific macro activities and/or TD types.

The technologies recommended in the TDM Guidelines should be adopted according to macro activities and TD types that need to be dealt with in the project.

How to use it?



All stakeholders can use these guidelines to support decision-making on actions concerned with TDM in software projects.

Then, the team should (1) **define which TDM macro activities** should be adopted in their software project to deal with TD items, considering the project's context. Next, they should **(2) read** and **(3) consider** the practical actions (activities, tasks, and recommendations) provided in the guidelines of each defined macro activity. Then, the understanding of the practical actions should be aligned among all the team.

The TDM Guidelines do not aim to replace the everyday software development activities or the original methods in more traditional software projects. Nevertheless, these guidelines can be **(3) combined** with the existing activities, methods, and technologies already in use, mainly those related to internal quality software. Finally, the team should **(4) perform** their established practical actions to deal with TD items in the project.

Practical TDM Guidelines

The TDM Guidelines contain fundamental concepts related to understanding and management of Technical Debt. Therefore, it is recommended that the team be aware of these concepts when using it. These concepts are explained in the Glossary of terms on TDM.

When planning or performing TDM actions, team members can assign the **Activities**, **Tasks**, and **Recommendations** in different statuses throughout software product planning, development, and evolution iterations, recalling that the TDM guidelines can be used iteratively, following the project cycles.

Each **Practical Action** can be marked as:

- **Done** - if it is already completed.
- **To Do** - if it is an expected activity for the next phases.
- **Not Applicable (N/A)** - if it is not in the project plan.

It is possible to add comments and details in the "**Notes**" Field to better organize project information about the planning and performing practical actions to deal with TD items.

Next....

PREVENTION OF TD ITEMS

PREV_1. Understand the TD phenomenon: Team members need to be aware of what is Technical Debt (TD), as well as its main types, causes, and impacts.

		To Do	Done	N/A
Planning Iterations	**PREV_T1.** Plan and promote meetings, training, or workshops to team members about the occurrence of TD in software projects, such as its main types, causes, and impacts. **Recommendations (R):**			
	R1_PREV_T1. Define adequate moments to do it. These events can be conducted at the beginning of the project or when they are required by the teams. Besides, create or select adequate materials to be used in this event. These materials should make explicit that TD is related to internal quality software. See here an example of material that can be used as a base.			
Development and Evolution Iterations	**PREV_T2.** Identify and communicate to team members about the project's circumstances that may lead them to assume TD items intentionally. It includes making the TD's benefits explicit for a long time and the most suitable times to accept intentional TD items.			

PREV_2. Define and use adequate SE technologies to prevent TD: project ' members can define and adopt technologies to prevent the occurrence of TD items as well as to minimize their risks.

		To Do	Done	N/A
Planning Iterations	**PREV_T3.** Identify and define adequate Software Engineering (SE) technologies (i.e., practices, methods, techniques, and tools) that can be adopted by project members to avoid or reduce the occurrence of issues related to internal software quality. It should consider the project's context, such as the adopted software development process and technologies. **Recommendations (R):**			
	R1_PREV_T3. The proposed Artifact 1 (Mapping of useful actions, artifacts, and technologies) can be used for support in identifying and defining which and how SE actions, artifacts, and technologies can be adopted to avoid or reduce the occurrence of unintentional issues related to the internal quality software product. The information mapped can be registered in proposed Artifact 2 (List of Required Actions, Artifacts, Technologies, and Potential TD items). Besides, see here the list of some technologies to prevent TD items.			

PREV_2. Define and use adequate SE technologies to prevent TD: project ' members can define and adopt technologies to prevent the occurrence of TD items as well as to minimize their risks.				
Development and Evolution Iterations	**PREV_T4.** Adopt the defined SE technologies in the project to avoid or reduce the emergence of internal software quality issues.			

NOTES

IDENTIFICATION OF TD ITEMS

IDT_1. Map the possible TD items, criteria, and acceptable levels to identify them: The occurrence of possible TD items and criteria to support their identification can be previously mapped in the early stages of the project.

		To Do	Done	N/A
Planning Iterations	**IDT_T1.** Map potential issues that can occur (intentionally and unintentionally) in the project, impacting software evolution and maintenance activities. These issues are TD items related to non-compliance with the required internal quality software, actions, and technologies. Each TD item is associated with a TD type. This mapping should consider the technical project's context. **Recommendations (R):**			
	R1_IDT_T1. Project members should identify the possible issues related to non-compliance among the performed activities, artifacts, technologies, and the required quality standards. The outcome can be used as a list containing information about the potential TD items that can emerge during the project's lifecycle.			
	R2_IDT_T1. This information can be registered on the proposed Artifact 2 (List of Required Actions, Artifacts, Technologies, and Potential TD items - Potential TD items Section).			
	IDT_T2. Define specific criteria and/or acceptance levels to support identifying the mapped potential TD items and their types, mainly those that cannot be identified automatically. It can include defining what types of debts can be accepted and their respective acceptance percentages. **Recommendations (R):**			
	R1_IDT_T2. Define specific criteria to observe problems related to required standards and practices such as requirements, documentation, code, architecture, design, tests, and versioning.			
	R2_IDT_T2. This information can be registered on the proposed Artifact 2 (List of Required Actions, Artifacts, Technologies, and Potential TD items - Criteria Section).			

IDT_2. Define and use specific technologies to identify TD: project members can define and adopt technologies to support the identification of TD items.

		To Do	Done	N/A
Planning Iterations	**IDT_T3.** Identify and define technologies that should be used to support the identification of TD items. It should consider the different TD types that can occur in the project and the possible ways to identify such TD (e.g., semi-automatic or manual identification). These technologies refer to tools for static analysis of source code or specific strategies, practices, and checklists. **Recommendations (R):**			
	R1_IDT_T3. Look for specific technologies that can be used to support the identification of TD items. See here the list of some technologies to identify TD items.			
Development and Evolution Iterations	**IDT_T4.** Periodically identify the TD items that emerged intentionality or unintentionality throughout the project. The identification of TD items can be performed in different project phases, according to the adopted development practices. For example, in each project's iteration (at the beginning or the end). **Recommendations (R):**			
	R1_IDT_T4. Use the defined technologies to identification of TD items. The proposed Artifact 3 (Checklist to support the inspection of TD items) can be used as a guide to drive the identification of possible inconsistencies related to SE actions, practices, and technologies that are not meeting the required standards which such inconsistencies may hinder software maintenance and evolution activities.			
	R2_IDT_T4. If relevant, use the list containing the required actions, artifacts, technologies, and potential TD items mapped (Artifact 2) as a basis for supporting the comparison between the required standards and status of activities and software artifacts.			

IDT_3. Create a backlog of TD: this makes it easier and more explicit for team members to identify, measure, prioritize, report, and track TD items without making big changes to their workflow.

		To Do	Done	N/A
Planning Iterations	**IDT_T5.** Create and maintain a backlog list of the identified TD items. **Recommendations (R):**			
	R1_IDT_T5. The backlog can be structured as a spreadsheet, a documentation artifact, or structured in management tools. If relevant, use the proposed Artifact 4 (TD Management Worksheet - Section of Backlog of TD) to register relevant information about TD items.			
Development and Evolution	**IDT_T6.** Classify and register information about each identified TD item. This involves describing the TD items, their type, related project' iteration, and status. **Recommendations (R):**			

IDT_3. Create a backlog of TD: this makes it easier and more explicit for team members to identify, measure, prioritize, report, and track TD items without making big changes to their workflow.				
	R1_IDT_T6. Team members can register this information at specific moments of the project, such as in retrospectives meetings and at the beginning or end of each project iteration. If relevant, use the proposed Artifact 4 (TD Management Worksheet - Section of Backlog of TD) to register such information.			

NOTES:

MEASUREMENT OF TD ITEMS

MEA_1. Define and use specific technologies to measure TD: project members can define and adopt technologies to properly estimate the costs related to TD items.

		To Do	Done	N/A
Planning Iterations	**MEA_T1.** Identify and define adequate SE technology that can be used to support the measure of the costs (interest and principal) of TD items. **Recommendations (R):**			
	R1_MEA_T1. Look for specific SE technologies proposed for TD measurement or techniques and practices adopted in the project to estimate effort/costs/time of tasks that can be used to measure the costs for measurement of TD items. See here the list of some technologies to measure TD items.			
Development and Evolution Iterations	**MEA_T2.** Adopt the defined SE technologies to measure TD items.			

MEA_2. Analyze scenario change: the possible scenario changes of the project related to each TD item can be mapped to help them estimate the interest of each TD item.

		To Do	Done	N/A
Development and Evolution Iterations	**MEA_T3.** Map and describe the possible scenario changes that may occur in future project cycles and their potential risks related to each TD item, for example, changes in project' members, short deadlines, and inclusion of new requirements. **Recommendations (R):**			
	R1_MEA_T3. If relevant, use the proposed Artifact 5 (Template of Documentation of TD items -Possible Change Scenario) to register the mapped scenarios.			
	MEA_T4. Estimate the probability of occurrence for each mapped scenario. The likelihood varies with different time frames. Then, this probability should be estimated by considering some specific time. **Recommendations (R):**			
	R1_MEA_T4. Measurement scales and/or estimative practices adopted in the project can be used for such probability. For example, scales for evaluation of impact and likelihood of risks.			

MEA_3. Estimate the costs of TD: the costs regarding principal, interest, and total can be estimated for each TD item to properly measure them.				
Development and Evolution Iterations		**To Do**	**Done**	**N/A**
	MEA_T5. Estimate the current cost (principal) for repayment of each TD item. **Recommendations (R):**			
	R1_MEA_T5. Use the defined SE technologies to support the measurement of the principal of TD items.			
	R2_MEA_T5. Historical data about efforts estimative can be used to achieve a more accurate estimation beyond the initial assessment (high/medium/low).			
	MEA_T6. Estimate the accumulated interest for each TD item. **Recommendations (R):**			
	R1_MEA_T6. The interest can be estimated based on the predicted scenarios. Besides, if relevant, the dependence between TD items also can be considered to estimate the TD interest.			
	R2_MEA_T6. Use the defined SE technologies to support the measurement of the interest of TD items.			
	MEA_T7. Estimate the total cost for each TD item. This estimative should consider the sum of principal and interest values.			

NOTES:

PRIORITIZATION OF TD ITEMS

PRI_1. Define and use specific criteria to prioritize TD: criteria can be defined and used to support prioritizing TD items.

		To Do	Done	N/A
Planning Iterations	**PRI_T1.** Define which criteria should be used to support the prioritization and the decision-making about the payment of TD items. **Recommendations (R):**			
	R1_PRI_T1. When applicable, one or more criteria can be defined to support the prioritization of TD items. Such criteria include business values, the impact on internal quality, and the costs of TD items. See the list of some of such criteria here.			
Development and Evolution Iterations	**PRI_T2.** Adopt the defined criteria in the context of the TD prioritization strategy.			

PRI_2. Define and use specific SE technologies to prioritize TD items: project members can define and adopt technologies to adequate order prioritization of repayment of TD items.

		To Do	Done	N/A
Planning Iterations	**PRI_T3.** Design a strategy to prioritize TD items by considering specific scenarios, prioritization criteria, and SE technologies. **Recommendations (R):**			
	R1_PRI_T3. Define the main scenario that will be used to drive the prioritization and payment strategies of TD items in the project. To do it, consider the following scenarios: **The scenario of TD Prioritization 1:** Consider the end of one iteration/release and the beginning of another. Important features are planned for the software product or one of its components in the next iteration/release. Then, the existing TD items that may impact the development or maintenance of such features must be paid down simultaneously. So, define which and how many items should be paid for. To do it, use the specified criteria and/or strategy for ranking and repayment of TD items. **The scenario of TD Prioritization 2:** TD items are increasing or decreasing for a software product or one of its components, and there are enough TD items to justify devoting resources to paying it down (perhaps a percentual of the project's iterations or an entire iteration/release. So, define which and how many items should be paid for. To do it, use the specified criteria and/or strategy for ranking and repayment of TD items.			

PRI_2. Define and use specific SE technologies to prioritize TD items: project members can define and adopt technologies to adequate order prioritization of repayment of TD items.				
	R2_PRI_T3. Define how the established criteria should be used and assessed. It includes defining a scale to represent (quantitatively or qualitatively) the TD items against such criteria as Radio Scale, Likert Scale, and Visual Analogue Scale.			
	R3_PRI_T3. Identify the dependencies if the dependence among TD items or the dependence between TD items and features were defined as criteria to be considered in the prioritization of TD items. A traceability matrix can be used to identify and track such dependences. If relevant, use the proposed Artifact 5 (Documentation of TD items - Related Features and Dependence on other TD items) to record information about such dependences.			
	R4_PRI_T3. Some prioritization strategies' characteristics regarding criteria assessment can be used as a base to design a TD prioritization strategy. Some examples of prioritization strategies, but not limited to, are Risk and Impact Matrix, Multicriteria analysis, MOSCOW, RICE, BASICO, GUT, WSJF, Technical Certainty x Business Agreement, and agile prioritization techniques.			
	R5_PRI_T3. If relevant, define the proper moments (milestones) in which the TD items should be prioritized. For instance, the (re)prioritization of TD items can be performed at the end or beginning of each project iteration.			
Planning Iterations	**PRI_T4.** Identify and define technologies that can be used to support the prioritization of TD items. **Recommendations (R):**			
	R1_PRI_T4. Look for specific technologies proposed for TD prioritization or traditional prioritization strategies that can be used to support the prioritizing of TD items. See the list of some such technologies for TD prioritization here. Besides, establish how and when such technologies will be used.			
Development and Evolution Iterations	**PRI_T5.** Evaluate (qualitatively or quantitatively) each TD item from the TD backlog according to the defined scenario, technologies, and/or strategy for TD prioritization. Besides, this evaluation should be performed in the defined milestones, according to team members' decisions. **Recommendations (R):**			
	R1_PRI_T5. If the Scenario of TD Prioritization 1 was defined as relevant to the moment, select only those TD items associated with the features planned for the next iteration/release to be evaluated. If applicable, identify the relationship between TD items from backlog vs. features from the previous iteration and features from the last iteration vs. the features planned for the next iteration to support the selection of TD items to be evaluated.			
	R2_PRI_T5. Suppose the Scenario of TD Prioritization 2 was defined as relevant to the moment. In that case, all TD items from the backlog should be (re) assessed.			

PRI_2. Define and use specific SE technologies to prioritize TD items: project members can define and adopt technologies to adequate order prioritization of repayment of TD items.				
	R3_PRI_T5. Identify and consider the dependence among the TD selected for prioritization if appropriate.			
	R4_PRI_T5. The main output of this activity should be a list of prioritized TD items to be paid.			

NOTES:

REPAYMENT OF TD ITEMS

REP_1. Define and use specific SE technologies to repay TD: project 'members can define and adopt specific SE technologies to proper repay TD items.				
		To Do	**Done**	**N/A**
Planning Iterations	**REP_T1.** Design a strategy to repay TD items, considering the defined milestones, efforts, and technologies to perform this action. **Recommendations (R):**			
	R1_REP_T1. Define how each TD type can be repaid. For example, Refactoring can be adopted to repay Code or Design debts; Testing Planning can be assumed to repay Test debts related to a lack of test cases. Then, some SE activities and/or technologies can be established to repay specific TD types.			
	R2_REP_T1. Establish the number of efforts/hours allocated to repay TD items. For instance, about 10% percent of the hours from a project or each iteration can be saved to repay TD items. It should consider the project's schedule.			
	R3_REP_T1. Establish the proper moments (milestones) at which team members must repay TD items (i.e., in specific project iterations or all project iterations). For instance, the prioritized and selected TD items can be repaid in all project iterations according to the established number of efforts/hours for this purpose.			
	R4_REP_T1. When applicable, define specific team members or profiles responsible for repaying the TD items.			
	REP_T2. Identify and define SE technologies that can be used to support the repayment of TD items. **Recommendations (R):**			
	R1_REP_T2. Look for specific SE technologies proposed for TD repayment or proper SE technologies that can be used to support the prioritizing of TD items. It should consider mainly the SE technologies adopted in the project that also can be used to repay different TD types. See the list of some such technologies here.			

REP_2. Perform proper actions to repay TD: project 'members should perform appropriate actions to repay those TD items prioritized, according to the designed strategy of TD repayment.				
		To Do	**Done**	**N/A**
Planning Iterations	**REP_T3.** Identify and select the TD items to be paid from those prioritized in the backlog. **Recommendations (R):**			
	R1_REP_T3. Consider the number of efforts/hours established to repay TD items in the project.			
Development and Evolution Iterations	**REP_T4.** Perform proper actions to repay each TD item. It should consider the defined strategy and technologies to repay.			

NOTES:

DOCUMENTATION OF TD ITEMS

DOC_1. Define and use specific SE technologies to document TD: project members can define and adopt particular SE technologies to support the documentation of TD items.

		To Do	Done	N/A
Planning Iterations	**DOC_T1.** Identify and define SE technologies that can be used to support the documentation and communication of TD items. **Recommendations (R):**			
	R1_DOC_T1. If relevant, use the proposed Artifact 5 (Template for documenting TD items). This template can be tailored or instantiated to other artifacts/tools used in the project's context, such as a worksheet.			
	R2_DOC_T1. Look for specific SE technologies proposed for TD documenting or proper SE technologies that can be used for this purpose. These technologies should have the potential to inform stakeholders about the existing TD items in the project. See the list of some such technologies here.			
Development and Evolution Iterations	**DOC_T2.** Adopt the defined SE technologies to support the documentation and communication of TD items.			

DOC_2. Register and Communicate information regarding TD items and decisions about them: information about TD items should be registered and communicated to stakeholders to make the management of such debts more effective.

		To Do	Done	N/A
Development and Evolution Iterations	**DOC_T3.** Register information of each TD item from the backlog to support decision-making. Some relevant information about TD items to be registered is its data of occurrence, intentionally, type, identified causes, potential impacts, compromised internal quality attributes, estimated costs (principal, interest, and total), measured criticality, estimated priority, possible scenarios' changes, and status. **Recommendations (R):**			
	R1_DOC_T3. If relevant, use the proposed Artifact 5 (Template for documenting TD items). To drive the documentation of each TD item.			
	R2_DOC_T3. Use the defined technologies to document TD items.			
	DOC_T4. Update, when applicable, the information about each unpaid TD item. For instance, it can be done in each project's iteration for those outstanding TD items.			

DOC_2. Register and Communicate information regarding TD items and decisions about them: information about TD items should be registered and communicated to stakeholders to make the management of such debts more effective.				
	DOC_T5. Communicate to the stakeholders the existence of TD items. **Recommendations (R):**			
	R1_DOC_T5. Use the defined technologies to communicate to the stakeholders the existence and information about TD items. Besides, TD items can be communicated to stakeholders at technical project meetings and reported using tools for management and communication adopted in the project.			

NOTES:

MONITORING OF TD ITEMS

MON_1. Define and use specific SE technologies to monitor TD: project members can define and adopt particular SE technologies to support the monitoring of TD items.

		To Do	Done	N/A
Planning Iterations	**MON_T1.** Identify and define SE technologies that can be used to support the monitoring of TD items. **Recommendations (R):**			
	R2_MON_T1. Look for specific SE technologies proposed for TD monitoring or proper SE technologies that can be used for this purpose. See the list of some such technologies for TD monitoring here.			
Development and Evolution Iterations	**MON_T2.** Adopt the defined SE technologies to support tracking TD items during the project's phases.			

MON_2. Define and use specific indicators and metrics to monitor TD: project members can define and adopt indicators and metrics to help them monitor TD items.

		To Do	Done	N/A
Planning Iterations	**MON_T3.** Identify and define indicators and/or metrics that can be used to monitor TD items during the project's phases. **Recommendations (R):**			
	R1_MON_T3. Established which and how such indicators and/or metrics can be estimated and used to support the decision-making. Examples of indicators are total of TD; a total of TD by type and/or context of occurrence; a total of TD treated; percentage of TD by type; percentage of TD by iteration; a total of estimated principal and interest; and total of TD by causes. These indicators can be associated with the software products, their components, or the project's iterations. It also includes defining proper moments in the project for using such indicators.			
Development and Evolution Iterations	**MON_T4.** Adopt the defined indicators and metrics for monitoring TD items to help team members make decisions about such debts.			

MON_3. Track continuously TD items: TD items should be tracked continuously throughout the development and evolution of software products.				
		To Do	**Done**	**N/A**
Development and Evolution Iterations	**MON_T5.** Track continuously the occurrence of TD items in the project. Use all defined actions, criteria, and technologies to identify, measure, prioritize and monitor TD items. Then, in each project's iteration, the following actions can be carried out: **Recommendations (R):**			
	R1_MON_T5. Identify the existence of new TD items.			
	R2_MON_T5. Reassess – (re)estimate, (re)prioritize, and update (do information about the pendent and paid TD items.			
	R3_MON_T5. Analyze the indicators related to TD items against the whole software product or its components to help team members in decision-making. **Question for the selected scenario of TD Prioritization 1:** Are there TD items that could impact the Important features planned for the next iteration/release? Then, should some debt be paid down at the same time? If so, how much, and which items should be paid? **Question for selected Scenario of TD Prioritization 2:** Are TD items increasing or decreasing for a software product or one of its components? Are there enough TD items to justify devoting resources to paying it down?			
	MON_T6. Use visualization mechanisms to support tracking TD items and make them explicit to stakeholders. **Recommendations (R):**			
	R1_MON_T6. Plot aggregated indicators/measures over time to support the analyzing trends about TD items.			
	R2_MON_T6. Use graphs and dashboards to summarize the aggregated information about TD items			

NOTES:

CONCLUSION

Summary Results

The total of marked practical actions in the guidelines indicate:

Compliance with TDM Guidelines Items			
Macro Activities	TO DO	DONE	NOT APPLICABLE
Prevention			
Identification			
Measurement			
Prioritization			
Repayment			
Documentation			
Monitoring			

Important Notes

1. Depending on the project plan, revisit the practical actions provided in TDM Guidelines and make the necessary adjustments to combine them with actions adopted to deal with internal software quality issues.
2. The practical actions provided in TDM Guidelines also can be used to support the teams in performing actions related to the maintenance and evolution of software products.

FURTHER INFORMATION

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Institutions and Fundings

The TDM Guidelines were structured into the context of a doctoral research in the ESE-Group of the PESC/COPPE/UFRJ. The Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001, and the Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro (IFRJ) partially supported this research. Helvio J. Junior is Professor at IFRJ. Professor Travassos is a CNPq Researcher (304234/2018-4) and CNE Faperj (E-26/201.170/2021).

Related References to TDM Guidelines

About the Perspective on TD and its Management

- Junior, H. J., & Travassos, G. H. (2022). Consolidating a Common Perspective on Technical Debt and its Management Through a Tertiary Study. Information and Software Technology, 106964. Link: https://doi.org/10.1016/j.infsof.2022.106964.

About the Software Industry Perception of TD and its Management and Supporting Technologies

- Silva, V., Jeronimo, H., & Travassos, G. H. (2018). Technical debt management in Brazilian software organizations: a need, an expectation, or a fact? Link: https://doi.org/10.1145/3275245.3275267.
- Silva, V. M., Junior, H. J., & Travassos, G. H. (2019). A taste of the software industry perception of technical debt and its management in Brazil. Link: https://doi.org/10.5753/jserd.2019.19.
- Apa, C., Solari, M., Vallespir, D., & Travassos, G. H. (2020). A Taste of the Software Industry Perception of Technical Debt and its Management in Uruguay: A survey in software industry. Link: https://doi.org/10.1145/3382494.3421463.
- Apa, C., Jeronimo, H., Nascimento, L. M., Vallespir, D., & Travassos, G. H. (2020). The perception and management of technical debt in software startups. Link: https://link.springer.com/book/10.1007/978-3-030-35983-6.