Establishing sustained use of Work Domain Analysis: A collaborative approach between Academia and Professional Practice

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Abstract. Work Domain Analysis (WDA) supports the understanding of socio-technical work environments and demonstrated its utility across various domains. Long-lasting adoption remains still limited; challenges go beyond the theoretical complexity and poses opportunities for longer collaborations between academia and industry for its sustained use. This paper discusses current methods and practices in organizations that can be mapped to the levels of abstraction portrayed in the WDA. With this example, we want to highlight that its use can be found across various levels of organizations and thus shows links to be integrated into various work environments. The adoption of WDA in organizations can be sustained if taking further steps that are recommended in this paper.

Keywords: Work Domain Analysis, Collaboration, Socio-Technical Systems

1 Introduction

In today's complex socio-technical environments such as aviation or healthcare, organizations face growing challenges in designing systems that align with operational goals, regulatory constraints, and user needs. Methods like Work Domain Analysis (WDA) have been taken up by various professional practices, organizations and industries (hereafter used synonymously in this paper). The purpose of using WDA in industries [1-4] is to understand the work environments in order to identify how the goals of the defined system underlie various levels of functions, processes, and their most granular, physical forms. Depicted as a core component of the Cognitive Work Analysis (CWA) framework, WDA has provided a base for developing an Ecological Interface Design (EID) [5] for monitoring systems and supporting decision-making across domains [6-10].
Academia has long contributed methods for analyzing such systems, yet the uptake of the WDA approach in the long term within industry remains limited.

Despite overarching strategic goals, many organizations operate in functional silos, with departments focusing narrowly on tasks, tools that support their 'best practice'

approaches, or performance metrics that often lack continuity and are not always well connected across the organization hierarchy. Although frameworks are adopted as 'best practice' for example through leaders of departments, they may frequently change due to reorganization or attrition. This can lead to misaligned priorities, inefficiencies, and missed opportunities for coordination. WDA offers a systems-oriented perspective that can help uncover shared goals and constraints across departments, fostering communication and integrated decision-making.

While literature demonstrates the utility of WDA in various domains, there is limited research on how organizations and academic partners can collaboratively apply and adapt WDA to support internal learning and sustained practice. Such collaboration can help organizations not only adopt WDA effectively but also embed it into their analytical repertoire, enabling them to revisit and refine work systems over time.

We propose that such collaborations on WDA between organizations and academia provide various opportunities and are not limited to the following:

- Opportunity 1: WDA helps develop a holistic understanding and cross-functional alignment which can facilitate decision-making.
- Opportunity 2: WDA can support training of professionals by representing roles and responsibilities. These can also be beneficial for onboarding purposes to gain understanding of their work on a broader scale within the organization.
- Opportunity 3: WDA enables the understanding of work constraints and match between operations and regulatory standards.

However, there are also challenges organizations face in their long-term uptake of WDA in the continuation of their work processes:

- Challenge 1: WDA appears as a theoretical method and is often perceived as abstract and complex. The outputs of the WDA can be difficult to interpret or use for decision-making purposes.
  Organizations often seek implementable solutions with quick wins while WDA proposes rather a high-level analysis and system understanding.
- Challenge 2: Silos make it difficult to make cross-functional analyses.
  They often have differing goals, tools and metrics, and can sometimes even be conflicting. Reaching agreement on a shared understanding can be fragmented. There can be various reasons for silos, e.g. different department structures, profit centers and mindsets of individuals.
- Challenge 3: Constantly changing requirements and scopes require WDA to be adjusted. In fast-changing environments, we may face changes in regulations or stakeholder requirements which can necessitate an updated WDA model. The abstract and at the same time depth of WDA can add to the workload and time constraint.
- Challenge 4: Organizations have their own set of tools and methodologies which are difficult to abandon. WDA would require training and active work by all stakeholders. For example, hospital staff often use task-based design methods like workflow mapping; when showing a WDA, many parts of the

WDA are left unused or simplified into flowcharts which take away the depth of the WDA.

Although many organizations reach out to academia to collaborate on conducting WDA studies, the lasting integration of WDA into everyday organizational practices remains uncertain. To constitute higher acceptance and long-lasting adoption of WDA, we propose a model that portrays opportunities for organizations on various levels for long-term uptake. In this paper, we ask:
How can collaboration between academia and professional practice support the sustained use of Work Domain Analysis within organizations?

2 Theory

The WDA portrays an environment that is controlled by the user which requires the definition of boundaries. The starting point is to define the system of interest [11]. The aspects that are being controlled are part of the system boundaries.

The Abstraction Hierarchy is the tool to show the Work Domain Analysis. (Rasmussen, 1985).The structure can be composed into levels or tree-like structures.

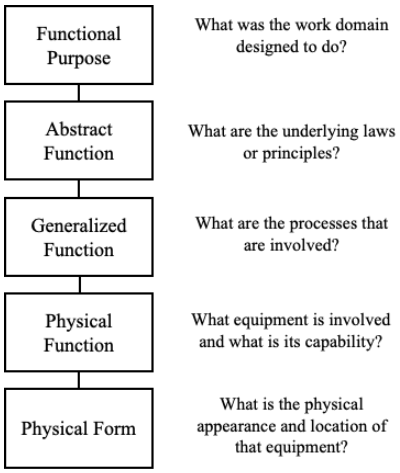

Fig. 1: The five levels of the Abstraction Hierarchy [11]

The top level called the *functional purpose* level defines the goals, values and constraints of the work or system of interest. The priorities of the system or work are described in the *abstract function* level. Here, priority measures, flow of values can be pointed out. The level of *generalized functions* describes the activities and processes. *Physical functions* can be referred to as the physical activities, processes including the equipment's capability representations. The appearance, location or configuration of equipment or objects are displayed on the *physical form* level. [11, 12]

The so-called means-end links show the connection between each level and portray how or why they are related. For example, aspects listed in the physical form level would be linked to the physical functions level through its means-end link describing how its physical function is achieved. [11]

3 Current practices of academia and organizations to develop a WDA

Our observations and studies conducted in various work domains (e.g., healthcare, finance, aviation) show that often, when academic researchers and professionals from organizations get together to develop a WDA, they go through various steps:

- *Step 1:* Gaining in-depth insights into the system or work environment that is being analyzed (e.g., literature, previously conducted work or analyses of the organization, available resources being presented by professionals from organizations etc.)
- *Step 2:* Planning the studies, e.g. ethnographies, interviews to model the actual environment or system of analysis (often done by academic researchers)
- *Step 3:* Mapping of the Abstraction Hierarchy (AH) as a tool of WDA (prepared by academic researchers)
- *Step 4:* Discussing the AH with subject matter experts and iterate the AH if needed (conducted by academic researchers)
- *Step 5:* Publications of the WDA findings to the organization as well as in academic settings (done by academic researchers and sometimes reports prepared by professionals from the organization)

These steps often conclude the collaborative work between both academic and organizational partners.

4 Recommended practices for a collaborative approach between academia and professional practice

The collaboration between academia and organizations often ends at the point of having established a formal report or publication about the WDA in the applied field. However, it remains still unclear why organizations do not take up the WDA as an additional skill or toolset for various analyses in their organizations and train further employees on this method. In the future, adjacent fields of research can be considered to evaluate transfer potentials to address the adoption of WDA. Specifically, Beckmann et al. [13] provide an overview, based on literature, of requirements, shortcomings as well as success factors and barriers of methods in design research. These findings can be taken into account and their potential applicability in this context can be assessed with regards to WDA. Another thought refers to the approaches to transfer methods from academia into practice, which are depicted in [14] and can be taken as an inspiration for further research.
Three dimensions for testing the validity of a methodical object (e.g. model, design method, framework) in an experimental study to assess the validity can be found in Üreten et al. [15]: the applicability, usefulness and acceptance. This concept can be applied to WDA.

We hereby propose steps that can support organizations to use WDA in the long run and use it as a method or toolset to analyze various work environments or systems, as

a continuation to the previously depicted 5 steps according to our observations and experiences working with various organizations and domains:

- *Step 6:* Organize follow-ups between academia and the organization to revisit the proposed models to get insights into its practical implementations, and identify changes related to the defined system or environment. Organizations may require training more employees on the WDA method to create awareness and constitute understanding on various levels of the organization. This would demonstrate applicability of WDA's use even in times of requirement changes.
- *Step 7:* Establish long-term adoption. Translate the WDA approach to other systems and work environments within the organization. The usefulness of WDA can thus be shown for various work contexts and connect silos with each other, creating abstract shared understanding.
- *Step 8:* Identify measures to detect its long-lasting effects in various departments within the organization. Establishing such measures can facilitate acceptance of WDA's use across various departments.
- *Step 9:* De-couple from academia having implemented WDA practices into various departments of the organization.

Potential formats for academia-industry collaborations for follow-ups can be found in [16]. These include, but are not limited to, seminars, competitions, studies and collaborative publications.

5 Discussion

In this paper, we present that WDA has been used for various domain purposes to collaborate between academia and organizations. Yet, the uptake in organizations has not been long-lasting, it remains to be discussed what organizations currently use instead of WDA and what the use of WDA implies for academia and organizations. Looking beyond WDA, we will briefly discuss other approaches that link academic and organizational practices.

5.1 Relatable practices of organizations mapped to WDA

Various methods are already being implemented in organizations to strategize, organize, operate and execute work within their environment. We can see that the levels of abstraction represented on the AH relate to organizations' methods and practices in various departments. The following examples show relations of such to the AH and are not limited to the representation below.

Organizations often use Balanced Scorecards to map out a strategic framework connecting to business goals and measurable objectives. The strategic level links to the *functional purpose* level in the AH.

Practices of lean thinking or six sigma are ways that organizations use to focus on priority management and optimizing efficiency. Agile software development and project management principles are further examples that can relate to the *abstract function* level in the AH.

In the operations department within organizations, designing an interface can be regarded as a process (e.g., UX design, UX research, Content Design, Accessibility). Parallels in healthcare to describe this level of the *generalized function* could be moving a patient from one unit to the other.

Design tools like Figma [17] or other research tools can be found in organizations, relating to the *physical function* level. Further examples from healthcare would be a hemostat to stop bleeding or lathe in manufacturing.

Their smaller components relate to both digital and physical artefacts. For example, digital artefacts would be design wireframes, programming codes or other ways of documentation. Examples of physical objects could be equipment such as stethoscopes used in healthcare settings. These relate to the *physical form* level in the AH.

These examples display some methods and tools organizations use and relate to Challenge 4 depicted in the introduction. Although tools and methods organizations currently use may be difficult to abandon, WDA would not replace the current practices but show greater connectedness and a way to abstract on various levels. The dynamics in organizations require adaptation of approaches, methods and processes which also apply to WDA; learning to use and constitute a WDA as a toolset would enable to also adjust the WDA models to new requirements (Challenge 3). Adapting existing frameworks and tools to company-specific needs can increase their use and ultimately, acceptance.
Applying WDA across departments could facilitate merging silos and enhance cross-departmental understanding, align cross-departmental performance metrics and make sure these metrics are not too short-sighted (Challenge 2). The initial perception on WDA being theoretical could lessen with time if applied and adjusted throughout multiple processes in organizations (Challenge 1) and enable viewing measurable outcomes to organizations to accept its long-term use.

5.2 Implications for academia and organizations

In academic settings, theories arise from observed principles in the environment. The WDA has its roots in cognitive systems engineering and portrays an example of industry demands' mapping into a systematic approach. Through various applications of WDA in different socio-technical fields it has shown applicability to a great variety of environments and real-life contexts. Collaborations between academia and organizations facilitate the translation between theory and practice.

The often-following steps after a WDA also imply that through a systematic representation, it can help enable improved system monitoring and reduction of errors.

It remains to be explored which metrics a WDA-based approach will likely improve in the organization.

Through the collaboration, academics can gain insights into organizations' system constraints, regulatory expectations, and operational limits.

At the same time, organizations benefit from a strong alignment between strategic, operational and technical goals, gaining a better picture of how work is done within its defined constraints. A system that highlights the shared purposes across the levels of abstraction can reduce working in silos and enable intradepartmental collaborations.

While academic expertise supports the uptake of WDA within the organization, also oftentimes for complex sociotechnical systems, it can create awareness for improving decision support systems and risk management operations. The systematic way of WDA can be learned and used as a toolset by professionals offering templates, visual aids or integration with familiar tools commonly used in organizations. This would enable practical uptake and enhance long-term organizational learning as well as reduce investments on non-prioritized work.

Beyond WDA, there are further frameworks that can be used for academic-professional practice collaboration. For example, so-called "HWID Action Cards" that are based on a theoretical framework for "Human Work Interaction Design" can be used to guide reflective Socio-Technical Design [18]. HWID action cards are concise, one-page guides designed to assist consultants throughout the socio-technical design process. Serving a similar purpose as checklists or standard operating procedures, these cards draw inspiration from diverse fields such as disaster management and educational metacognition. They can be used normatively to guide consultants' actions in real-time or descriptively to prompt reflection on actions taken or imagined. Each card supports both practical steps and deeper metacognitive awareness, enabling consultants to think critically about their design choices. Organized into four main categories—needs and problems, ideation sketches, hypothesis prototyping, and interventions—the cards cover tasks like defining organizational issues, sketching workflows, and testing user experiences. Contextual elements such as organizational, national, or technological environments are also considered. Each card outlines when and how it should be used, who is responsible, and which team members are involved in the process. These tools promote flexible and thoughtful consultancy practices, particularly in dynamic, real-world business environments [18]. Other socio-technical approaches such as socioinformatics [19] or consultants use of notions of usability and UX as core concepts in socio-technical systems development [20] are relevant to consider for academic-professional practice knowledge transfer.

5.3 Limitations

We have observed common steps that take place between academia and organizations to collaborate on WDA; however, the proposed follow-up steps have not been evaluated

yet nor put into practice. These steps remain to be discussed and can benefit from further perspectives on collaborations between various stakeholders.

6 Conclusion

In this paper, we portray our common perception on academic and organizational collaboration on the use of WDA. Although practices may vary from partner to partner, we propose additional steps to keep WDA as a meaningful and useful method for organizations to keep in their skillset and make use of it in various work environments and system analyses across departments. While WDA can be taken up into the repertoire of methods within organizations, we propose that long term uptake can be achieved through follow ups of academic partners within the organization to detect its practical implementations and changes to the defined system or environment. The transferability of WDA can be facilitated to other departments to enhance collaboration and communication, reducing working in silos. Training professionals on this method is profitable to enable long-lasting evaluation of the effects across the organization. The de-coupling phase from academia can once be done when the knowledge and practical skills are manifested within the organization.

References

1. Read, G.J.M.: Extension and application of cognitive work analysis to improve pedestrian safety at rail level crossings, Doctoral dissertation, Monash University, (2015)
2. Zúñiga, E. R., Yasue, N., Hirose, T., Nomoto, H., & Sawaragi, T.: An integrated discrete-event simulation with functional resonance analysis and work domain analysis methods for industry 4.0 implementation. Decision Analytics Journal, 9, 100323(2023)
3. Memisevic, R., Sanderson, P., Choudhury, S., & Wong, B. L.: Work domain analysis and ecological interface design for hydropower system monitoring and control. In 2005 IEEE international conference on systems, man and cybernetics (Vol. 4, pp. 3580-3587). IEEE (2005)
4. Uereten, E.: Models of Cognitive Work Analysis in Neurocritical Care and Perspectives on Expertise–An Ecological Interface Design Approach (2023)
5. McIlroy, R. C., & Stanton, N. A.: Ecological interface design two decades on: Whatever happened to the SRK taxonomy? IEEE Transactions on Human-Machine Systems, 45(2), 145-163 (2015)
6. Ho, D., & Burns, C. M.: Ecological interface design in aviation domains: Work domain analysis of automated collision detection and avoidance. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 47, No. 1, pp. 119-123). Sage CA: Los Angeles, CA: SAGE Publications (2003)
7. Jamieson, G. A., Miller, C. A., Ho, W. H., & Vicente, K. J.: Integrating task-and work domain-based work analyses in ecological interface design: A process control case study. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 37(6), 887-905 (2007)
8. Shier, A.: Applying Ecological Interface Design to Improve a Radiation Therapy Interface. University of Toronto (Canada) (2014)
9. Li, Y.: Exploring Automated Trading: Modeling a Financial System with a Variable Degree of Automation, Display Design, and Evaluation (2017)

10. Dikmen, M.: A cognitive work analysis approach to explainable artificial intelligence in non-expert financial decision-making (2022)
11. Burns, C. M., & Hajdukiewicz, J.: Ecological interface design. CRC Press (2017)
12. Rasmussen, J., Pejtersen, A. M., & Schmidt, K.: Taxonomy for cognitive work analysis. Risø National Laboratory (1990)
13. Beckmann, G.; Gebhardt, N.; Krause, D.: Transfer of Methods For Developing Modular Product Families into Practice - An Interview Study. 13th International Design Conference - Design 2014, pp. 121 – 130, Dubrovnik (2014)
14. Beckmann G.; Gebhardt N.; Bahns T.; Krause D.: Approach to Transfer Methods for Developing Modular Product Families into Practice. 14th International Design Conference DESIGN 2016, pp. 1185 – 1194, Dubrovnik (2016)
15. Üreten, S.; Eisenmann, M.; Nelius, T.; Cao, S.; Matthiesen, S.; Krause, D.: A Concept Map for Design Method Experiments in Product Development - A Guideline for Method Developers, Proceedings of the 30th Symposium Design for X (DFX 2019), pp. 147-158. Jesteburg, Germany (2019)
16. Üreten, S.; Sankowski, O.; Krause, D.: Aktuelle Ansätze in der Methodenforschung, in: Krause, D.; Hartwich, T. S.; Rennpferdt, C. (Hrsg.): Produktentwicklung und Konstruktionstechnik, Forschungsergebnisse und -projekte der Jahre 2016 bis 2020, Springer Verlag, Berlin, pp. 31-64, Heidelberg, Germany (2020)
17. Figma homepage, https://www.figma.com/, last accessed 2025/05/30
18. Clemmensen, T.: Human work interaction design: A platform for theory and action. Springer Nature (2021)
19. Wulf, V., Pipek, V., Randall, D., Rohde, M., Schmidt, K., & Stevens, G. (Eds.): Socio-informatics. Oxford University Press (2018)
20. Rajanen, M., & Rajanen, D. (2020). Usability as speculum mundi: A core concept in socio-technical systems development. Complex Systems Informatics and Modeling Quarterly, (22), 49-59 (2020)