DUVis: A visual analytics tool for supporting a trans-disciplinary project

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ABSTRACT

We present DUVis, a visual analytics application developed to support the analysis and appraisal, of the transdiciplinary project Dŵr Uisce, from internal project managers and external stakeholders. DUVis provides a number of visualizations and additional features to facilitate data exploration of a project's progress. It presents a map of stakeholders' activities, and their engagement with each other, as well as outputs, workpackages, their completion status and potential impact. We present our preliminary design and provide a blueprint for further development.

Index Terms: Human-centered computing—Visualization—Visualization systems and tools;

1 INTRODUCTION

We present the DUVis visualization tool, an open-source Web-based research project management visualization tool, built to support transdiciplinary projects. Trans-disciplinary research (TDR) brings together different disciplines, and recognizes the value of engaging with external partners and stakeholders from outside the academic sphere [6]. TDR projects typically involve a large volume of collaborators, often spanning institutions, nations and continents. Consequently, collaboration and communication are of paramount importance for the success of TDR projects. However, tracking collaboration and ensuring continued communication can be challenging, especially as a project grows and expands. Our research proposes a method of visualizing aspects of such collaborations and facilitating data exploration within a complex TDR project, such as our use case, the Dŵr Uisce Project. Dŵr Uisce (a name comprising of the Welsh and Irish words for water), is a transdisciplinary EU-Funded project, with a goal to scientifically investigate, and develop innovative practices towards improving efficiency and energy performance of water supply and consumption. Dŵr Uisce's organizational structure is typical of many collaborative, multi-partner research projects. Activities are broken down into work-packages, which have a leading partner and various internal (to the project) and external stakeholders. Each work-package has a duration, associated work-packages, and a series of planned and unplanned (at the project's conception and funding application) deliverables. DUVisis specifically designed to visualize these aspects and the overall project structure.

2 RELATED WORK

Past reviews of TDR [5] reveal a lack of generic agreed-upon management structures or tools to help support TDR projects, which inevitably leads to 're-inventing the wheel' through a 'learn by doing' approach [5]. Visualization tools, due to their data-centric nature, have the potential to provide a foundation upon which such structures can be developed and eventually adopted.

Indeed, the impact of visualization in different domains has been the focal point of many research efforts [2], with visualization systems offering powerful interactive tools that allow us to understand the data, underlying structures and dynamics of different domains and applications. Moreover, the use of visual metaphors in knowledge and project management is common practice, where different depictions are used to motivate, illustrate collaborations, and portray productivity [3,4]. For example, Gantt charts are a popular visualization which are used traditionally to visualize project processes, work-packages, and their relationships, and are often expected by funders, as part of funding proposals.

3 THE DUVIS VISUALIZATION TOOL

The main objective of DUVis is to visualize the structural linkages between activities and work-packages within a research project, and consequently assist with the evaluation of said project after its completion, by supporting stakeholders in their reporting activities, usually required as evidence of a project impact and fulfillment.

The team: Our team included researchers, members of the Dŵr Uisceproject, from a range of disciplines collaborating closely with one another. Two teams were involved, a group of visualization researchers (*developers*), and a group of domain experts (*data managers*). Data managers captured project data in spreadsheets, as is common practice in most project teams. These were subsequently formalized to a consistent data model, by both groups, followed by iterative ideation stages before agreeing on the final tool design.

The data: The final dataset, used in DUVis comprises four tables: a) *work packages*, which are a common way of grouping project activities by category or relevance to one another, as well as mapping to the UN Sustainable Development Goals(SDGs; [7]), b) *activities*, which describe individual project activities as defined in the project progress and synopsis reports, which contains the majority of the information visualized by DUVis, c) *links* between project stakeholders and activities, describing collaborations within the project, and d) *stakeholders* which are organizations that have engaged in some way with the Dŵr Uisce project but are not part of the research institutes responsible for it. The level of engagement of each stakeholder is calculated as the sum of the number of said stakeholder's connections per engagement level (four levels: inform, consult, share, co-create, adapted from [1]) multiplied by that engagement level, and mapped to a continuous color scale.

The tool: DUVis is built with ReactJS, Cytoscape.js for the node-link diagram, Vega-lite for time-series and bar-chart visualizations, and vis.js for Gantt charts. The design is centered around a force directed node-link diagram, connecting stakeholders, workpackages and activities (see Fig. 1. Any of the graphical elements (activities, work-packages, and stakeholders) can be re positioned manually by clicking and dragging or automatically by re-running the layout algorithm. In the main view, each activity is represented by a circular node and links between them are non-directional edges. Each activity node is weighted according to the number of connections it has.

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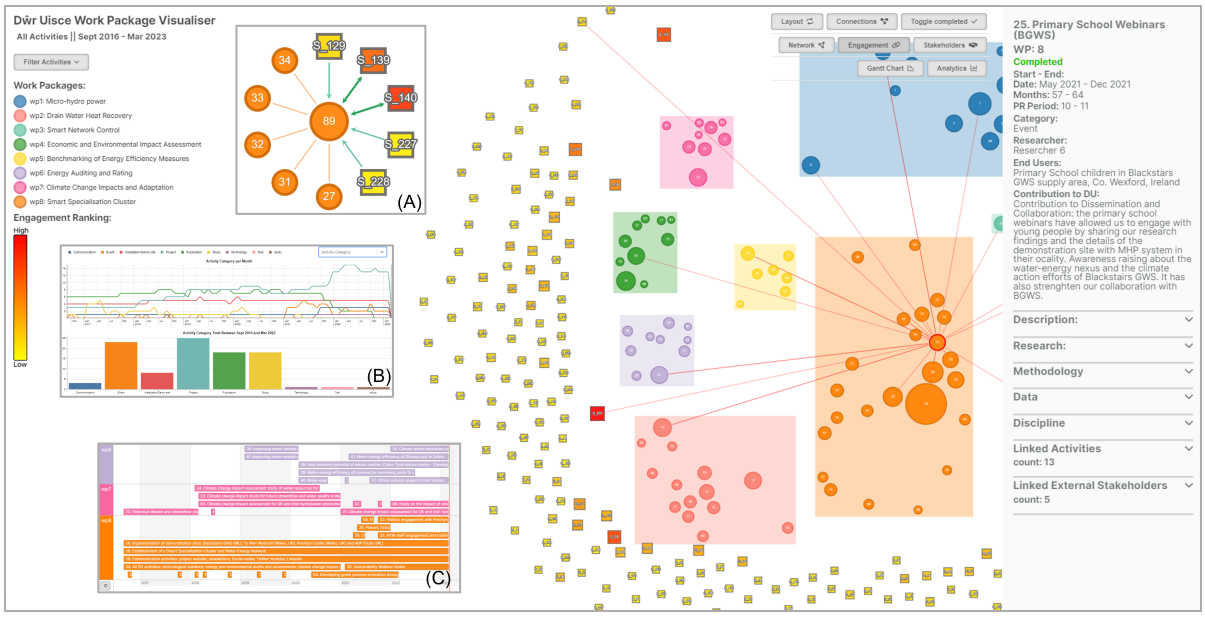

Figure 1: DUVis overview. In the main view, a node-link diagram depicts project work packages (colored rectangular nodes), activities (circular nodes within work packages) and external stakeholders (square nodes). Selected node's edges are highlighted, hiding all other graph edges. On the right, a panel displays information about selected element. A filtering interface allows the modification of the current view. A legend provides a work package color key and the stakeholder engagement ranking scale. The buttons at the top right of the main interface allow users to view secondary visualizations, three of which are depicted; a stakeholder network view (A); a detailed activity analytics panel (B); a gantt chart (C).

Nodes are grouped and color coded by their work-packages which are represented as rectangular parent nodes. External stakeholders are represented by square nodes, also weighted according to the number of connections they have. Connections between stakeholders and activities are represented by either directed or non-directed edges depending on the view, hidden by default to reduce over-plotting. Edges are either hidden by default (stakeholder) or aggregated (activities within workpackage), to reduce overplotting.

4 Lessons Learned

Overall, DUVis acts as a showcase for the potential visualization tools may have in research project management. Nevertheless, we must note that the development of DUVis was an afterthought in the Dŵr Uisce project (6.5 years duration), taking place over the last eight months. Consequently, we faced challenges, mainly around limitation on the originally recorded data. For example, DUVis was designed to map how collaboration yielded project outputs. However, our dataset did not contain metrics on quality or timeliness of said outputs. Consequently, the user can not definitively appraise the collaboration outcome. Additionally, activity outputs are often inputs to other activities; however, with no planned delivery of outputs recorded in our dataset, it is impossible to determine whether activities that ran longer than planned ended up producing bottlenecks and deferring other tasks. That information had not been recorded or had been lost at some point over the project's lifetime. Similar issues were encountered in other aspects of the dataset, such as stakeholder meetings, in promptu communications etc. highlighting the need for rigorous data logging from the outset.

The use of a system like DUVis from planning through to completion of a research project would encourage a more data-driven approach to project record keeping. With metrics such as the suggested output delivery times, as well as indications of expected output quality (e.g., engagement in workshops, quality of publications, levels of adoption of new technologies and best practice) recorded from the start of the project, it would be possible to build a much clearer picture of the knock-on effects collaborations and activities have on one another. Furthermore, this would be translated into simple metrics that could be used to indicate the success (or lack of) of different activities and the factors that played in to that i.e. late outcome delivery, poor collaboration etc.

As Dŵr Uisce has a fairly typical structure for large EU-funded projects, we believe that DUVis can form the basis for a generalized tool that offers support for visualizing important project meta-data, and can be used by a variety of project stakeholders. We are working towards the enhancement of our prototype, and adding features for supporting the ongoing management of projects, as well as their preparation during the proposal stage.

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