Organising methods enabling integration for value creation in complex projects

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Abstract

Purpose – The purpose of this paper is to identify the areas and logic of integration of different stakeholders using different methods and to analyse their applicability and challenges in practical projects. The main aim is to describe how these different methods impact value creation.

Design/methodology/approach – Action design research was carried out in a large hospital construction project where the first author acted as an "involved researcher" and the second author acted as an "outside researcher". Two workshops were organised to evaluate the direct and indirect challenges and benefits of the applied four methods and to explain how different methods enable value creation.

Findings – All the studied methods provide good results in terms of usability and commitment to the aims of the project, thus delivering the direct benefits expected. Process, people and tools logic works well in this case project when applying the methods properly. Significant evidence was provided on secondary deliverables of the methods, and all analysed methods had a significant impact in the area of leading people, clarifying what "focus on people" means and how it is enabled.

Practical implications – Focus on people can be achieved through different operative methods if applied in the right way. It is necessary to select the most suitable methods based on all the direct and indirect deliverables.

Originality/value – This case project offered a platform to analyse integration methods in a real-life project using the collaborative contract method. The authors were able to participate in the analysis by taking action from the very beginning of the project in terms of training, learning, continuous development and coaching of these methods and evaluating the applicability.

Keywords Integration, ADR, Lean, Value creation, Tools, Methods, Complex projects, PPT

Paper type Research paper

1. Introduction

Combined with high uncertainty and the growing size and complexity of projects (Jefferies *et al.*, 2014), the traditional project delivery process in the construction industry is associated with fragmentation (Egan, 2002; Lavikka *et al.*, 2015), the isolation of professionals, the lack of standardised project management practices, poor coordination (Dainty *et al.*, 2001a, 2001b; Egan, 1998; Anumba and Evbuomwan, 1997) and poor communication (Blacud *et al.*, 2009;

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Kamara *et al.*, 2000; Gunasekaran and Love, 1998). It is recognised that the fragmented transactional agreement of the traditional approach has a negative impact on team dynamics. It drives team effort to achieve agreement rather than to find optimal solutions (Forgues and Koskela, 2009). In addition to fragmentation, the traditional construction delivery method has been challenged for years by low trust and collaboration issues, which has led to budget overruns and project delays (Larsen *et al.*, 2016; Cheung *et al.*, 2013).

The construction industry has also been criticised for its low productivity development (Pekuri *et al.*, 2011) because of waste – both material-related waste and process-related waste, such as sharing information (Merikallio and Haapasalo, 2009) that does not add value to the customer (Womack and Jones, 1996). Much process-based waste could be avoided through better planning in the early stages of projects. Traditional methods may not motivate stakeholders to work integrated, innovatively and towards customer goals; therefore, we need to look for other ways to work together (Davies *et al.*, 2007; Brady *et al.*, 2006).

The commercial and contractual structure of a project may also impede co-operation (Hietajärvi *et al.*, 2017); therefore, the integrated project delivery (IPD) approach known as relative contracts has been proposed as a solution to harmonise stakeholder objectives, provide common incentives and facilitate better co-operation between different organisations (Matthews and Howell, 2005; Hietajärvi *et al.*, 2017; Rowlinson, 2017). Integration within a project aims to address the relational issues in the industry by attempting to foster positive collaboration based on respect and trust (Morledge and Adnan, 2005; Pishdad-Bozorgi and Beliveau, 2016). Integration is sought through collaborative methods, which are the procedures and tools used in the operational activities of a project to enable the parties to work more effectively to achieve the project objectives and to stimulate behaviour that promotes an environment where information is freely exchanged between the parties (Baiden and Price, 2011; Egan, 2002). In the construction industry, the success of integration has improved the performance of project teams (Hietajärvi *et al.*, 2017). The list of different methods and tools is extensive and growing (Merikallio and Haapasalo, 2009). For example, Mitropoulos and Tatum (2000) have proposed the classification of contractual (e.g. goal setting, incentives, plans, formal rules and practices), organisational (guidelines, structures and informal interaction, such as common workspace) and technological (information and communication technology, Last Planner System [LPS], etc). mechanisms.

In relation to all this, successful project delivery from a managerial perspective depends on the mechanisms with which the knowledge and experience of stakeholders can be combined into the "best of the project" (Aapaoja *et al.*, 2013). The main steps of management are (Robbins and Coulter, 2018) planning, organising, leading and controlling. The objective of this paper is to identify the areas and logic of integration of different stakeholders using different methods and to analyse the applicability and challenges of these methods in a practical project (a complex hospital project). Our main aim is to describe how these different methods impact value creation. To that end, the following research questions must be answered:

RQ1. What are the main areas and respective methods for creating integration within a project?

RQ2. What are the challenges and experiences relating to these methods in a complex hospital project?

RQ3. How do different tools impact collaborative value creation?

Our research approach is qualitative, following the logic of action design research (ADR) (Sein *et al.*, 2011). We first reviewed the literature on IPD and project team integration, thus providing the foundation to analyse integration within a project (*RQ1*). In our study, we

selected one large hospital planning, design and construction project as our unit of analysis. Our empirical data merge internal experiences of the project, analytically collected in workshops from the project stakeholders, providing challenges and experiences of the applicability of different integration methods (*RQ2*). We then explain through what mechanisms different methods enable integration (*RQ3*).

2. Literature review on integrated project delivery and project team integration

Moore and Dainty (1999) have shown that the successful implementation of projects and the performance of the construction industry largely depend on the mechanisms through which the knowledge and experience of many people can be combined in a team. Integration within a project requires that teams and individuals with different skills, knowledge and expertise who may not have worked together in the past be well integrated, which can be complicated (Baiden *et al.*, 2006; Ibrahim *et al.*, 2013). This integration process does not happen automatically, often because of a lack of co-operation, an inconsistent vision (Hietajärvi *et al.*, 2017), poor communication and insufficient participation by team members. Integration refers to linking different organisations or parts of organisations to achieve desired goals. However, stakeholder involvement and integration has proven very challenging, particularly for complex projects (Haapasalo, 2018). Therefore, many industry-led reports (Bourn, 2001; Egan, 1998; Egan, 2002) have urged the industry to change its traditional practices and improve performance through increased collaboration.

2.1 Integrated project delivery

IPD is a project delivery method to integrate people, systems, business structures and practices into a process that collaboratively harnesses the contributions and insights of all participants to optimise project results (for "the best of the project"), increase customer value, reduce waste and maximise efficiency (Aapaoja *et al.*, 2013; Azhar *et al.*, 2013; Sakal, 2005). IPD is characterised by liability waivers among key participants, the early involvement of key participants, close co-operation between the participants and the integration of each participant's unique contribution into the decision-making process and into jointly developed project goals, always with the aim of optimising the whole project rather than satisfying self-interest (Fischer *et al.*, 2017; AIA, 2014; Thomsen *et al.*, 2009). In IPD, collaborative project implementation methods enable deeper co-operation and participation through common risks, profits and goals (Olander and Landin, 2005; Lahdenperä, 2009; Sive, 2009). The criteria for achieving the desired results are based on the principles of good faith and trust, an open-book approach (Davis and Love, 2011; Love *et al.*, 2011; Jefferies *et al.*, 2014; Lloyd-Walker *et al.*, 2014; Walker and Lloyd-Walker, 2015), a no-blame culture, best for the project, a commitment to indisputability, a unanimous decision-making process and a common governance structure (Walker and Lloyd-Walker, 2015).

In the construction industry, project integration is usually managed through a variety of formal and informal integration methods, the procedures and tools used in the operational activities of a project to help the involved parties work more effectively to achieve the project objectives (Merikallio and Haapasalo, 2009). The organisation and commercial terms of an IPD project are typically defined in IPD contracts that are signed before the project begins. The processes and methods that refer to how collaboration between project participants is conducted and managed in a general and day-to-day manner represent the core of the IPD operating system (Thomsen *et al.*, 2009).

2.2 Project team integration

Teams are used in organisations because they are capable of transcending the efforts of individuals acting alone, especially when performance requires multiple skills and expert judgement (Hayes, 2002; Scarnati, 2001). Project team integration means merging different disciplines or organisations with different goals, needs and cultures into one cohesive and mutually supportive unit (Baiden *et al.*, 2006; Fischer, 1989) where processes and cultures are coordinated in a collaborative way (Ochieng and Price, 2009). In the construction industry, integration often refers to collaborative practices, methods and behaviours that promote an environment where information is freely exchanged between different parties. One management strategy to facilitate more positive, co-operative and collaborative teamwork is team integration (Egan, 2002), which improves efficiency and performance (Egan, 2002; Baiden and Price, 2011).

Baiden *et al.* (2006) have highlighted six key dimensions of team integration that describe a fully integrated team. To begin, an integrated team should have *common goals and focus* only on project implementation (Moore and Dainty, 1999, 2001; Love and Gunasekaran, 1998; Winch and Bonke, 2002). In addition, an integrated team needs a project outcome that benefits each actor and operational activities that should be *completely free of organisational boundaries* (Fleming and Koppelman, 1996; Baiden *et al.*, 2006). When benefits are shared among integrated project teams, risks also need to be shared. This is usually supported by the disclosure of accounting documents related to the project implementation (Cohen, 2010). These things increase the predictability of the total cost and the schedule (Anumba *et al.*, 2002). Through *shared risks and benefits*, team members are dependent on each other's abilities and are thus encouraged to share their knowledge to achieve optimal results (Laan *et al.*, 2011). The fact that everyone is "in the same boat" reduces the opportunistic behaviour of individual team members. The integrated team should strive *to work in a mutual place*, physical or virtual (Dainty *et al.*, 2001a, 2001b; Bromley *et al.*, 2003; Majava *et al.*, 2019), and there should be *no restrictions on sharing information* between teams (Evbuomwana and Anumba, 1998; Bromley *et al.*, 2003). The ability to share individual needs allows the project team to be aware of the interests of other members and can increase the likelihood that common goals can be developed and achieved. The team *atmosphere must be fair and respectful*, and a "no blame" culture should prevail (Dainty *et al.*, 2001a, 2001b). Finally, to unleash the full potential of cumulative knowledge, in a fully integrated team, each actor has an equal opportunity to participate in implementing the project (Love and Gunasekaran, 1998; Bromley *et al.*, 2003).

2.3 Methods and tools for interoperability and team integration

Co-operation management is emphasised in projects where there are many stakeholders or the size or complexity of the project increases. Morgan and Liker (2006) have proposed process, people and tools (PPT) logic for action development, where the idea is to use tools (T) to get people (P) to follow the process (P). The main aim is to optimise the process where people are the operators and tools are the means to enable the people to follow the process. In a construction project, combining interoperability and common tools and methods should result in joint action. The process of interoperability should be understood primarily through PPT logic, where the goal is interoperability and thus a successful project. Tools and procedures are ways to achieve a goal and not an end in themselves. Through interoperability, motivation and the ability to work towards common goals are achieved, which is further refined into systematic and agile decision-making during the project.

One way of managing interoperability and collaboration is to organise them into a collaboration process for the construction project. The collaboration process requires a

process owner responsible for ensuring the motivation and capabilities for a successful project (Haapasalo, 2018). The literature highlights many different tools and methods that support and promote the realisation of integration (Merikallio and Haapasalo, 2009). However, there are difficulties in introducing and using these methods, as there are so many methods that learning and applying them is a task in itself. In addition, their introduction requires a change in practices. One of the problems typical in construction is that the roles of different parties are different at different stages of a project, which requires an understanding of interoperability as a whole process.

The use of (lean manufacturing) tools and methods, advanced technologies transferred from the manufacturing industry, has been proposed for synchronous IPD collaboration, as they can improve the management of complex projects. The methods and tools most commonly used in IPD projects include the target value design (TVD) method, set-based design, LPS, design structure matrix techniques, the choosing by advantages (CBA) method, value stream mapping and visual management (Zhiliang *et al.*, 2018).

2.4 Literature synthesis

Collaboration between project stakeholders is the foundation of a successful project. Collaboration requires the integration of different stakeholders in different phases of the project, especially in the beginning, to remain on track. One typology of integration mechanisms is presented by Mitropoulos and Tatum (2000) and consists of contractual, organisational and technological integration mechanisms. Contractual mechanisms set the foundation for the entire project, technological mechanisms are typically just a matter of choice and organisational mechanisms cover the majority of leadership and management issues. Therefore, a more refined classification is needed for the development and implementation phases.

The literature covers many tools and methods relating to projects and project management (Zhiliang *et al.*, 2018). Following the idea of Morgan and Liker (2006), tools and methods should be used to encourage people to follow the process (PPT). Obviously, the tools and methods to be applied in a project should be carefully selected, as only the best-suited ones should be used. Selecting the best tools for different purposes, including integration and collaboration, can be challenging. According to Haapasalo (2018), tools can be roughly classified into four different categories based on their initial purpose of use:

(1) value engineering (planning and design *vis-à-vis* the project objectives, what can be achieved with what investments – customer value for money);

(2) leading people (motivating people to participate, collaborate and innovate – building trust);

(3) operative management of the process (operative game plan, scheduling and decision-making – process ownership within the project); and

(4) data and information management (single data and information repositories – product and project data and information systems).

3. Research method

Fundamentally this research is a case study and follows the principles of ADR (Sein *et al.*, 2011) (Figure 1). The selection of ADR was natural as one of the authors had a central and responsible role within the project, enabling an opportunity for the research to have deep access to the content and details of the project. Other approaches were considered but ADR was chosen as using and reflecting the used tools and methods has been a key responsibility

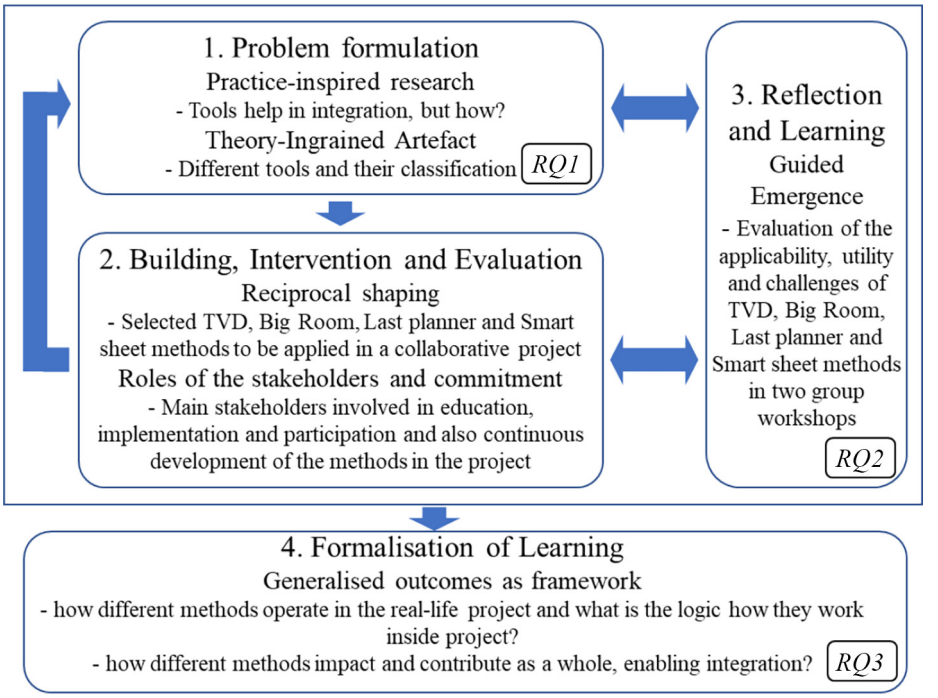

Figure 1.
Applied ADR research method

Source: (modified from Sein *et al.*, 2011)

for our author in action. This enabled us to depict the root causes of issues behind the applied tools and methods. ADR also enabled the iterative nature of research to reflect the decision-making and documentation of the project. In addition, the other author acted as the "outside researcher" to ensure the objectivity of the analysis and results to balance the research (Walsham, 2006) Naturally, also several members of the case study organisation participated in the application of the project tools and methods to secure that the applicability was on the right track and enable decision-making for the good of the project. The selection of the ADR method is rooted in the holistic nature of the research problem as the primary focus is on depicting and solving real-life problems (Sein *et al.*, 2011).

The applied ADR consist of four steps, including problem formulation; building, intervention and evaluation (BIE); reflection and learning; and formalisation of learning:

(1) *Problem formulation*: Typically, complex construction projects require collaboration and integration especially because of fragmentation – fragmented and distributed decision-making. The literature review outlines different types of integration mechanisms, tools and methods and categorises them into four main categories. However, the literature does not explain what methods to use and when, or how to classify these methods. Nor are the indirect benefits of these methods revealed, or how to balance the utilisation between the methods.

(2) *BIE*: In our case study, the OYS 2030 hospital project, the contract model has been a collaborative multi-party contract, which has necessitated novel solutions regarding the planning, organising, implementing and control of the project.

Because of the new collaborative contract model, an extensive emphasis on integration and collaboration methods was taking place already at the beginning of the project. Therefore, we have selected to analyse the TVD, Big Room, LPS and Smartsheet methods in terms of implementation, applicability and utility for our case project. For our research, we first described how the methods were applied and clarified which literature has been in the background. Then, the overall experiences were described based on the methods applied in action. The main stakeholders involved in the collaborative contract were involved in education, implementation, participation and continuous development of the methods while running the hospital project.

(3) *Reflection and learning*: For research purposes, we have formally evaluated the applicability and utility of the selected methods in two specific workshops. The workshops were carried out in both sub-projects, where the main contractor and building services contractors were different but the other service providers were the same (the hospital project was divided into two parallel allied sub-projects). The group workshops were attended by members of the alliance steering groups (in total 8 organisations and 9 members) and project management teams (in total 8 organisations and 14 members). The workshops resulted in documented evaluations, and both sessions were recorded for later analysis. The workshops aimed to evaluate the direct and indirect results or outputs of the tools and methods used and the challenges and benefits of their use. This analysis emphasises that the methods reflect not only the preliminary design but also the interplay between the stakeholders, that is, ongoing shaping by organisational use, perspectives and participants and by the outcomes of authentic, concurrent evaluation. This principle emphasises that the ADR team should be sensitive to signals that indicate such ongoing refinement, as the main idea of PPT logic suggests.

(4) *Formalisation of learning*: While steps 1–3 are iterative inside action taking, step 4 is more on the research side. Here, we have organised the things learnt from a BIE and evaluation into general solution concepts and outcomes and characterised them as design principles and further reflections. Of course, the methods in our analysis continue their own life and development in the case project and in subsequent projects, but our aim in this research was to learn how different methods operate in a real-life project and what is the logic and how they contribute within a project. As a final result of our ADR research, we formalised the learning into a framework that explains the logic of how different methods contribute as a whole to value creation and to enabling integration in complex projects.

The applied ADR has an aim to identify methods and tools for integrating different stakeholders. At the practical level, we need to evaluate applied tools and methods on "whether they work in practice or not" and what is their contribution to the project. In our study, we have carefully followed the ADR presented by Sein *et al.* (2011), described how the methods were applied in the case project and organised workshops where two reference groups separately evaluated the applicability through the same method (to avoid bias related to the involved researcher). The involved researcher, even though being part of the project, has only facilitated the evaluations, not participated in the evaluation process. From these evaluations, we extracted direct and indirect results, challenges and benefits. Finally, the learnings were formalised and discussed in relation to the earlier literature. The

validations are also carried out by the involved (action) researcher, including processes, participants and peer validation, to check and demonstrate the truth of our results.

The list of methods and tools is very long in the literature (Merikallio and Haapasalo, 2009; Zhiliang *et al.*, 2018), and also our case project has applied several methods in their activities. We have, however, selected just one tool from each integration and collaboration category for our analysis, to analyse four methods more deeply instead of 8 or 12 superficially. In our case project, we have analysed:

- TVD in value engineering;
- Big Room in leading people;
- LPS in operative management of the process; and
- Smartsheet in data and information management category.

The selection criteria for the aforementioned tools were:

- covering the main area of the represented integration and collaboration category;
- having been trained and used from the beginning of the project;
- project having descriptions for the application of these methods; and
- the availability and access of data for the research.

4. Analysis of integration tools and methods in an alliance project

4.1 Our case study – Northern Ostrobothnia Hospital District hospital construction project

Our case project is a hospital design and construction project for Northern Ostrobothnia Hospital District (NOHD). The implementation of this project was divided into two construction sub-projects launched in 2018 with a total duration of 5 years. The total budget for the construction project is over €600m, and the building is approximately 115,000 square metres and meets very high-quality standards. Because of the *complexity* and *uncertainty* of the project, a collaborative contract model was used (alliance model).

The aim of the development phase was to ensure that the requirements for the facilities, equipment and systems of end users (both medical and non-medical staff) are defined and that the stakeholders are committed to achieving them. The plans for the implementation phase of the project were prepared together with the client and the main project participants. In the development phase, more than 200 end users and several architects and engineers participated in defining the requirements and needs of the new operation. In the implementation phase, more than 600 people worked simultaneously on site and at the project office. The program is led by the NOHD, specifically the Program Management Office (PMO). The alliance is responsible for the project and for performing all operations for which internal expertise and resources are available, with the PMO directing and managing integration. Significant effort was put into establishing common rules, processes, tools and working methods in the project office and into explaining how to report and share information. A variety of methods and tools have been recognised as important for governance and integration. As part of the alliance implementation, we selected four different methods or tools for our analysis, one from each integration and collaboration discipline:

- value engineering (TVD);
- operative management of the process (LPS);
- leading people (Big Room); and
- data and information management (Smartsheet).

4.2 Target value design

4.2.1 Target value design method applied. TVD is a management practice to determine customer values and develop solutions to achieve the goals set by the owner and the goals set together with alliance partners during the development phase and achieve the desired targets. TVD is used to build and manage the project definition and design phases with the goal of generating value for the customer within the constraints set by the owner, which include cost, time, specific design criteria and end-user usage requirements. The principles of "value for money" and "best for the project" are used in the development of technical design solutions and the comparison of alternatives. The design solutions assess the cost–benefit ratio *vis-à-vis* the benefits to be achieved and help in determining a good, cost-effective option that meets the client's project objectives and financial boundaries and the end-user requirements in terms of facilities, equipment and systems. Plans are developed by comparing different solution options in working groups with the help of a multi-professional design team using the CBA method. To manage and control the scope of the project, design is divided into cross-functional TVD clusters, such as structural, electrical, construction technology, procurement and production. Teams are co-located in the project office and virtually and use a communication system to frequently update their cost estimates based on TVD team updates and estimates using the Smartsheet system, which is open to all project team members (Ballard and Howell, 1998; Ballard, 1997, 2000).

4.2.2 Experiences with the target value design method. Using TVD resulted in a collaborative process in the design aspect in the early stages of the project to meet the expectations of the owner and the project partners while keeping the costs and schedule under control. For the owner, the most critical success factors were co-operation in achieving the expected results and having all participants accept and fully commit to achieving the results. The direct output of TVD was the target cost estimate and initial data for the project's target costs. Transparency in terms of the costs and content of the design solutions was seen as vital in the TVD process.

TVD has also "forced" people to produce innovative solutions and develop plans to attain goals in a different way than usual. Multi-functionality and close collaboration with end users resulted in novel innovative approaches and tools to strengthen and enhance communication, collaboration and understanding between stakeholders. The (hidden) agendas and overlap of work diminished as the stakeholders worked and debated their opinions while justifying their positions, thus improving the project environment, building trust and increasing individual motivation.

Because of the traditional fragmented design process and multiple project stakeholders, understanding the meaning of TVD was challenging. In the collaborative contracts, it was crucial to make all participants understand that plans need to be designed according to goals and not the other way around. What was truly challenging was committing to the agreed process and the decisions made during the process. Therefore, managing both people and information was vital in TVD. Also of note was that TVD provided a common path for approaches and milestones in relation to the implementation timetable. All major sub-contracted and sourced entities were designed in accordance with TVD and LPS.

4.3 Last Planner System

4.3.1 Last Planner System applied. The aim of LPS is to manage the design and construction phases, to continuously monitor the effectiveness (*percentage of the plan completed*), to improve efficiency and communication by analysing the reasons for unfulfilled tasks and unmet schedules and to limit potential conflicts to achieve the set milestones. To make a project schedule more predictable, LPS manages the project schedule hierarchy at three

levels – the big picture schedule (*the master plan*) consisting of a layer-by-layer design schedule, design package schedules (phase planning) and a production schedule; the 3-month schedule (*lookahead planning*); and a weekly schedule (*the weekly work plan*) consisting of a weekly program. At the project level, planning is directed to schedule goals in the project with a design schedule adapted to the production schedule and the intermediate goals of the functional design. The layered schedule serves as a general schedule of the project in terms of design and provides the LPS wall with the most important monitoring points for the progress of the design for weekly work. The design schedule is divided into fixed, semi-fixed and variable parts for each level. It describes the endpoints of the functional design, that is, the moments when the technical design can start the floor design, as well as the locking points of the floor plans, in which case the plans are further transferred to production. The progress of the frame construction work on a floor-by-floor basis and the starting points of the interior production work are the most important factors in terms of synchronising the design. The schedule describes the most important work steps and durations in the various design areas to the nearest week. The design schedule is a tool for managing and monitoring the design phases and for managing the design resources and workload (Ballard, 1997, 1999, 2000; AlSehaimi *et al.*, 2014).

4.3.2 Experiences with the Last Planner System method. The immediate output of the LPS was controlled planning *vis-à-vis* the timetable goals through weekly LPS sessions on the LPS wall and regular planning meetings according to a weekly schedule. Weekly schedules were a tool for planning preparation, management, monitoring progress and weekly planning per the plan package. The LPS wall schedules tasks backwards from milestones, seeks to identify dependencies and records initial needs. Meetings in accordance with the weekly program are held to specify responsibilities, schedule planning tasks, identify initial information needs and agree on the necessary workshops.

Indirectly, LPS has improved planning and control practices while reducing uncertainty, as all participants are committed to the promises, and barriers are highlighted and openly discussed. The open discussion has also reduced uncertainty and fostered close relationships, participation and commitment to promises made with all stakeholders. Open collaboration has increased people's motivation and confidence in team members.

One of the noted challenges for LPS was identifying the right person at the right time to be the planner who can report the status of the current situation and who is able to or is obliged to take full responsibility for tasks that must be considered at any time. The new system was questioned because of the "this is what we have done before" thinking and because of a lack of understanding, skills, training and experience. The most challenging parts of the LPS process were the induction of team members, LPS implementation training at the beginning of the project and people and knowledge management. One aspect that was very poorly managed was continuous improvement.

The main benefits of LPS implementation were recognised in improving planning – operational, technical and production – and control practices, which facilitated better forecasting of resource use and reduced uncertainty. LPS sessions during the development phase also prepared project team members for collaboration and helped significantly in the integration of all participants.

4.4 Big Room

4.4.1 Big Room method applied. Big Room refers to both the common workspace reserved for a project and the "operation mode" in which designers, users, contractors and other operators work in direct interaction. In Big Room work, interaction, communication, ideation and problem-solving between operators is immediate, fast and effective in supporting the

realisation of project objectives. Big Room work also aims to create a good and productive spirit for the project. The team actively involved in Big Room varies according to the situation, and sometimes the parties can focus on other tasks but can join the activities as soon as the situation requires it. Communication is a direct, interpersonal activity where responses and feedback are received promptly. Big Room work is typically carried out in a physical space. In our case project, there were specific locations for collaboration and development purposes right from the beginning of the development phase. Later, the project office transformed into a virtual office building to be acquired in the vicinity of the construction site. The facilities enable different ways of working (e.g. group and individual work) and are equipped with a variety of "meeting spaces" (flipcharts, magnetic walls, touch screens, etc.). The project office is also equipped with computer-aided virtual environment (CAVE) equipment that enables efficient, user-oriented and interactive work. The project office jointly created a Big Room "operation mode" for the project and team members (Hietajärvi *et al.*, 2017; Majava *et al.*, 2019; Nyameke *et al.*, 2020).

There were specific Big Room days, three days a week, for participation when the main operators were physically present to participate in Big Room scheduled meetings, workshops, problem-solving, etc. The frequency of meetings varied based on a "best for the project" basis. Designers, contractors and customer and end-user representatives participated in the Big Room work. A weekly program in Big Room was jointly scheduled for the different teams and sub-teams where the meeting times for the management, project group, teams and sub-teams were agreed upon. Big Room is used in the project for user workshops and CAVE sessions, user and project meetings, workshops, virtual models, building information modelling (BIM) review sessions and "everyday work". Virtual space is also available when the group is not able to be physically present. The virtual environment was scheduled to be available on non-Big Room days for other operators to participate (Majava *et al.*, 2019; Dave *et al.*, 2015).

4.4.2 Experiences with the Big Room method. One of the most important and visible impacts is the creation of a physical space that provides an opportunity to connect multiple stakeholders to the project in terms of working and decision-making processes. A common space is the space where all project stakeholders work together for two to three days a week and provide a flexible communication and interactive environment where problems that arise can be solved in face-to-face discussions. In addition to the Big Room, a BIM infrastructure was set up and equipped with technological equipment for video conferencing and interactive meetings with end users (CAVE). The walls were equipped with technical drawings and descriptions of the processes and tools used and the design principles and schedules for the project. Dashboard walls are an important part of the Big Room and allow project team members to access real-time information. During the project, the dashboard walls were digitised, with Smartsheet sharing real-time information.

One of the indirect results of using Big Room was early involvement. When stakeholders were involved early in the process (the development phase), several potential problems were already resolved. As the most challenging tasks – such as setting target costs, scheduling, and assessing risks and opportunities to be achieved during the development phase – were carried out in advance on a collaborative basis, there were only minor disruptions during the implementation phase.

The global COVID-19 pandemic posed challenges in terms of face-to-face collaboration but intensified utilisation of virtuality in Big Room. In normal circumstances, one of the challenges is the requirement of the physical presence of project participants. Leadership and management were also among the biggest challenges for effective Big Room work. If

weekly work is not managed and facilitated and common rules agreed upon and followed, the achievement of opportunities deriving from the expected results will be impaired.

Several benefits of the Big Room concept were identified in terms of transparency and mutual respect and trust. The physical environment and team spirit help team members embrace the project; there is no hierarchical pressure in the work environment and everyone works with confidence and peace. A shared workspace speeds up the project delivery process if information sharing and communication is open, direct and fast.

4.5 Smartsheet

4.5.1 Smartsheet system applied. The Smartsheet system was implemented as a common platform to be used by each project participant and project stakeholder to help project management and the project team to manage and coordinate the ongoing workflow and change requests, to report on the decisions made and to visualise the real-time situation in relation to the project objectives. Smartsheet is a web-based application and team collaboration platform. Any member of the project team can log in from anywhere and get the information they need and update the information expected by others. Smartsheet has been used to manage tasks, schedules and collaboration tools that allow all participants to share their information and justify change orders or decisions. Smartsheet is widely used to monitor and manage different types of work, such as team and project to-do lists, the LPS wall in digital format, lists of the requirements and changes, comments and discussions on various issues, project decisions, requests for changes, cost estimates and budget forecasts. Based on the information entered on Smartsheet, the project manager is able to report on the status of projects to the steering group, and the situation is available online with both a mobile application and a web-based application on a computer to all key participants at various agreed levels of project stakeholders. The entry of data into the system has been defined in more detail for different workgroups and end users of the system clarifying the utilisation. Data alignment and data accuracy are also regularly reviewed within and between different working groups (Majava *et al.*, 2019; Liston *et al.*, 2001).

4.5.2 Experiences with the Smartsheet system. In our case project, all necessary and common information was accessible and available to all project participants simultaneously. All team members can see the decisions made, ongoing tasks, a list of requested and accepted changes and targeted cost and budget variations because of multiple changes. Transparency on progress and decisions made is considered very good, and information from others enables operators to better synchronise their own work to optimise the project. The challenge is to ensure that the right information is noted by the right person at the right time. The lack of information or a response from project stakeholders becomes critical in terms of progressing with project decisions. To create an environment of transparency, the sharing of information is essential for mutual respect and effective co-operation. Together with effective Big Room work, documenting and communicating the results of LPS and TVD sessions is a challenge in itself. There are still difficulties in making people understand the importance of using a common information platform and managing people and information.

4.6 Reflection and learning – challenges and experiences with the methods

Based on practical findings from our case project, the used tools and methods have proven very beneficial. Basically, all the applied methods not only resulted in their promises in their primary integration and collaboration areas but also enabled other indirect benefits (Table 1). For example, TVD makes people commit to common goals and collaborate more intensively than in traditional ways. Through the LPS scheduling, planning and managing the implementation, the actors "necessarily" co-operate and consider the actions of other parties. If there is

Table 1. Challenges and experiences with the methods applied in a complex hospital project

	Direct deliverable	Indirect result	Main challenge	Main benefits
TVD	• Setting customer objectives and allowable costs of the project. • Guiding design to achieve goals and value creation. • Developing cost- effective solutions to meet customer requirements and project constraints. • Clarifying and guiding design to meet the needs of end users in accordance with the principles agreed upon by the alliance.	• Managing and controlling the use of resources (medical staff, facilities and equipment). • Forcing people to innovate new solutions instead of traditional solutions. • Collaborative design harnesses the expertise of the different parties involved in the project (innovation and value for money). • Significantly contributing to integration.	• Understanding the TVD process in the same way among all parties. • Training and orientation have been challenging, as has facilitation and management. • The challenge is to get the right people to the right place at the right time. • Change management in the process (there was a number of changes).	• Concretisation of objectives and requirements. • Work on the project is progressing as planned and is on schedule. • The process takes into account the relationship between quality and cost in the right way. • The end result is created by working together; all parties are involved from start to finish. • Increasing understanding of what the end result will be.
LPS	• Concretising the timetable objectives with milestones and identifying obstacles, making action plans and designating those responsible. • Highlighting the interdependencies between the different parties. • Commit different parties/people to act as agreed.	• Reducing uncertainty and improving communication between project parties. • Right people in the right place at the right time. • In addition to managing things, controls how people do and manage.	• Training and orientation have been challenging, as has facilitation and management. • The challenge is to get the right people to the right place at the right time. • Changing the traditional “this has always been done	• Improving planning of one’s own work and the allocation of resources. • During the development phase, people got to know others better, which increased confidence. • Identify interdependencies between different tasks.

(*continued*)

Table 1.

	Direct deliverable	Indirect result	Main challenge	Main benefits
		• Increasing trust between the parties when solving obstacles and resource needs to achieve objectives.	before" way of thinking. • Active participation and commitment of responsible persons.	• Facilitates problem-solving. • Visualization improves communication.
Big Room	• A common workspace creates an excellent framework for open and direct communication. • Common up-to-date snapshot and fast information exchange. • A framework for rapid problem-solving and innovation. • Agile interaction and common guidelines as a result of expert co-operation.	• Effective team integration when sharing information and challenging a partner. • Helps to create a good and confidential atmosphere for the project and promote grouping. • Improve the cohesion and team spirit of project staff. • To expand one's own understanding and vision of the project as a whole.	• Getting the right people to the place at the right time. • Inefficient use of time and waste of resources if Big Room operations are not managed. • The COVID-19 pandemic brought its own challenges, but at the same time the use of the virtual Big Room was implemented. • Big Room operations have not been designed, managed or facilitated to reap the benefits.	• A common workplace with common rules and tools creates an effective framework for quality project management. • Improves communication, interaction and team spirit. • Data exchange at a low threshold, which accelerates decision-making. • Actively produces solutions to prevailing problems and devises new ways to solve them.
Smartsheet	• A common platform and information-sharing system creates an excellent framework for open and direct communication.	• A common information management system helps in team integration when information is shared openly with everyone.	• Information is expected when the provider has not remembered or had time to communicate it.	• The roles and responsibilities of the different parties in the project have been described through the

(*continued*)

	Direct deliverable	Indirect result	Main challenge	Main benefits
	• Taking responsibility for the right people and recording decisions and changes in a common database. • Better information management and timely decision-making.	• Sharing information with everyone at the same time also improves mutual trust. • In the same place information, cost, task and risk management and the promotion and monitoring of different areas.	• Providing guidance and training in the use of the tool received too little attention. • The challenge is to make different parties understand why Smartsheet is used.	management of Smartsheet tasks. • The information is in one place and can also be scattered to other systems and visualised (e.g. real-time snapshot) for everyone. • A good tool for managing a large number of decisions, changes and tasks; creates systematicity.

Table 1.

disagreement about the schedule and goals, each team member is obliged to state their reasons for not being able to commit to the agreed schedule/goals; otherwise, all actors commit to and contribute to achieving the goals.

Big Room as a method allows collaborative work and activities. It provides a context in which the design of physical space and activities, the rules of the project and the areas of responsibility are emphasised. Physical space is not important in itself, but it allows employees from different organisations, both permanent and project organisations, to work on a project and create a framework for teamwork and trust-building. Physical space allows for open interaction between people. However, working in a common space alone in itself increases collaboration and efficiency, unless activities are not planned and managed. Leading people is perhaps the most demanding and challenging part of integration and collaboration. For example, jointly agreed methods and tools guide people to pursue common goals and focus on the essentials. Creating common rules should be combined with team integration so that people also focus on the essentials of the various activities in the project.

Data and information management is naturally critical in any project. In a complex project, it should be planned before the project, and there should be dedicated sub-processes to clarify the operations creating a spirit of trust, resulting in commitment from the beginning and enabling quality data and information. In our case, Smartsheet provided a framework for open data exchange and real-time snapshot creation. Changes or inaccuracies in information resulted in discussion and collaborative problem-solving.

4.7 Formalisation of learning – the impact of tools on collaborative value creation

Our division for integration mechanisms roots in Mitropoulos and Tatum (2000) and is more accurately classified in categories for operative project level by Haapasalo (2018). According to our study, it is evident that tools created for their primary purposes typically deliver what they are planned for – some being worse and some better. However, the list of tools in the literature is so long that it does not make any sense to even try to apply them all. Therefore, it is important to select fewer methods and apply those effectively. In our study, we selected one tool for each category and analysed their direct deliverable, indirect result, challenges and benefits. In these categories, TVD provided a plan for optimal value, Big Room delivered motivation for people to participate, collaborate and innovate, that is, the created trust and the utilisation of LPS lead to an operative game plan for scheduling and decision-making, and finally, the Smartsheet provided a platform for single data and information repositories and sharing. However, this is only one part of the benefit of selecting the right methods for each category. In our study, all applied methods also had another indirect impact – "focus on people" (Figure 2). In other words, our research describes how to focus on people on a practical level, resulting in collaboration and finally successful value creation.

According to our findings, the "focus on people" can be achieved through methods if applied in planned and intentionally managed processes. Planning, organising, leading and controlling standardised processes; involving jointly agreed practices and tools; creating a common mindset; getting the right people at the right time; and continuous development and effective management of the Big Room are ways to get people to follow the process (PPT). When following the process, the project team creates an environment for themselves to succeed in achieving the goals and expectations set by the client and to create value for the project participants. These methods need to be planned before the project and need to be implemented very early in the project. These combined with interoperability in a project cause "automatic" joint action, resulting in leading the people. The process of co-operation must therefore be understood above all through PPT logic, where the final goal is

collaboration and thus a successful project. Methods and tools are the ways to achieve a goal and are not an end in themselves. It is also a fact that implementation tools and methods require training and learning, as well as continuous coaching. Tools and methods should be selected carefully; there should not be too many but enough to operationalise all four integration and collaboration disciplines, which are critical for the success of the project. According to our study, each tool not only resulted in achieving direct goals and deliverables but also indirectly resulted in several benefits in terms of leading the people, where the biggest challenges have been. Whatever tools and methods are used, the most important thing is to get the various stakeholders in the project to share and process information openly and commit to schedules and goals. All this makes it possible to achieve interoperability, which improves the motivation, ability and decision-making of project members, which in turn leads to a successful and value-creating project.

4.8 Discussion

Managing the people is a key to succeed in the project team integration and to achieve the goals of the owner and the project participants. However, it is very challenging to just start leading people. The integration should be sought through collaborative methods, which are the methods and tools used in the operational activities of a project to enable the parties to work more efficiently and to improve their ability to add value to achieve the project's objectives (Baiden *et al.*, 2006; Ochieng and Price, 2009; Payne *et al.*, 2003). Our four categories for integration and collaboration (value engineering, operative management of the process, leading people and data information management) proved a valid classification for methods and tools.

Overall, the selected tools including TVD, LPS and Smartsheet, together with the Big Room work environment, contributed significantly to people directing their efforts to integrate their skills and resources and to collaborate and stimulate their behaviour, fostering an environment where information is freely exchanged between individuals and parties. The aspects of interoperability described in the study are in fact inter-linked and cannot really be distinguished. For example, Last Planner is a time management method, but it results in collaboration. Based on the findings, the applied TVD process helps the customer and suppliers to understand the objectives of the project in the same way, in addition to defined value and collaboration. Leading people is perhaps the most demanding part of all, although the four categories provided different approaches for people involvement and engagement, as well as integration. For example, the jointly agreed and collaboratively coordinated project rules and processes integrate project participants into

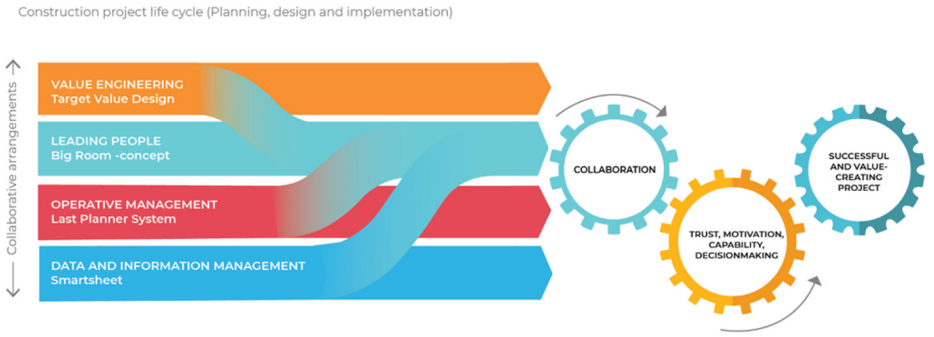

Figure 2.
Organising different methods to enable integration in complex projects – how different tools impact collaborative value creation

teams and guide people to pursue common goals and to focus on the essentials (Egan, 2002; Baiden *et al.*, 2006; Ochieng and Price, 2009; Payne *et al.*, 2003).

Integration refers to collaborative practices, methods and behaviour that promote an environment in which information is freely exchanged between different parties (Austin *et al.*, 2002; Baiden *et al.*, 2003) to make the best decisions (Baker and Salas, 1997; Steward and Barrick, 2000). This study confirmed that the challenge is to ensure that the right information arrives at the right person at the right time (Alshawi and Faraj, 2002; Ankrah *et al.*, 2009; Samuel, 1996). Therefore, Smartsheet was selected and validated in this study as a useful data-sharing platform and Big Room as a mutual work environment (Dainty *et al.*, 2001a, 2001b), where, for example, LPS and TVD sessions were held. However, bringing people together does not guarantee that they will work together effectively and make the right decisions, therefore there is a need to coordinate the efforts of team members to work together to achieve a common goal (Conti and Kleiner, 1997; Dickinson and McIntyre, 1997; Scarnati, 2001). Practical discussions and some of the literature (Morgan and Liker, 2006) repeat the 'focus on people' aspect, but how this is to be done has typically remained unanswered in the earlier literature. Here we have managed to shed some light.

5. Conclusion

Earlier research outlines the importance of integration and different methods of collaboration between stakeholders in projects. There is also much literature on the various tools and methods for efficient project implementation. However, there is very little research on what kind of tools to use, how to select tools and how to cover the main areas of a project without sacrificing an unnecessary amount of resources for tools and methods. A careful review of the literature leads us to a classification of the tools and methods into four disciplines:

(1) value engineering (TVD);

(2) leading people (Big Room,);

(3) operative management of the process (LPS); and

(4) data and information management (Smartsheet).

The critical principle presented by Morgan and Liker (2006) to use tools and procedures (T) is to get people (P) to follow the process (P), as the success of the process defines the end result.

In our study, we selected, used and analysed the challenges and experiences associated with the methods applied in a complex hospital project. Based on our results, the careful selection of fewer tools and methods facilitated better results and increased usability and commitment in terms of the purpose of using those tools. However, it is critical that these tools and methods are applied from the very beginning of the project and that ongoing training and coaching is provided. According to the results, PPT logic works well in our case project. It is also notable that the analysed tools and methods do not work only along with their primary purpose, but basically, all have also an indirect purpose. This evidence can be considered significant, verifying the idea of "focus on people". This highlights the criticality of selecting, learning and implementing the right tools and methods.

Our results are based on a single case study, and we aim to extend our analysis to other projects. The evidence has been collected from a well-functioning project that has had good progress and success based on evaluations. Therefore, we see that the results are reliable and can be applied or at least tested in other projects, as the results are not specifically construction oriented.

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