Knowledge Integration Through Resource Combining: The Case of a National Standard Framework for Hospital Design

KNOWLEDGE INTEGRATION THROUGH RESOURCE COMBINING: THE CASE OF A NATIONAL STANDARD FRAMEWORK FOR HOSPITAL DESIGN

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The hospital design process contains technical and organisational challenges. The paper investigates how the Swedish national healthcare project framework and database, Program for Technical Standard (PTS), is used to facilitate knowledge integration within and across hospital projects and the outcomes thereof. The study covers data from 7 Swedish regions based on 12 semi-structured interviews with 14 facility mangers, 2 property managers as well as the national system administrator for PTS. PTS is considered to support the design process; however, some actors also perceive that PTS as a standard is not compatible with the call for adaptation. By mapping how the specific resource, PTS, is combined differently in various resource constellations, the results show that the value is contingent on the integration (or lack of) of numerous technical and organisational resources interfaces within and across organisations, projects, and regions. In particular, the perceived value of using the standard framework relates to its integration with the client's internal resources and project processes, and the matureness of digital competence. The divergence of knowledge integration is shown to be present on a project level as well as on a national level among the regions.

Keywords: client; design process; network; health care

INTRODUCTION

During the last 10 years, many construction projects have been carried out (and are still being carried out) in Sweden to renew existing hospitals, which were primarily built 40-50 years ago (Ring, 2017). The total sum for investments in emergency hospitals alone amounts to just over SEK 100 billion (SOU 2021: 71). Renewal is necessary to update medical technology and support new healthcare provision to face existing and future challenges of an aging population, multi-sick patients, antibiotic resistance and spread of infections. The projects' early stages are commonly facing high uncertainties and in the framing process it is difficult to establish the content of the project and consequently, time and cost overruns are not uncommon. The design process of a hospital contains several technical and organisational difficulties, including the need to integrate knowledge from several actors, for example, the architect, facility management, health care experts and users as to create the right functionality of the building (Adams, 2008). Various digital technologies, foremost

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Sateei, S and Sundquist, V (2022) Knowledge Integration Through Resource Combining: The Case of a National Standard Framework for Hospital Design *In:* Tutesigensi, A and Neilson, C J (Eds) *Proceedings of the 38th Annual ARCOM Conference,* 5-7 September 2022, Glasgow, UK, Association of Researchers in Construction Management, 73-82.

BIM, has been advocated to substantially transform design and enable integration by facilitating communication and teamwork among the parties involved in the design (Merschbrook and Munkvold, 2015; Peansupap and Walker, 2005). One of the most profound challenges is the limitation to learn, apply, and facilitate knowledge integration across projects. The organising of interaction processes for knowledge integration within and across projects is thus of outmost importance, including routines for integrating gained knowledge and experiences back to the organisations to meet project budget and time frames.

The Swedish national healthcare project framework and database, PTS (Program for Technical Standard) aims to support decisions in early project stages concerning the right design, function, and quality of the building. PTS is available for the 21 Swedish regions that are individually responsible for their hospital projects. PTS is an ICT-system with system functions to support early stages in health care projects, including room layouts, and a network to share knowledge among users, projects, and regions. The role of establishing ICT systems to support and store knowledge has been brought forward in research of project settings due to their temporary nature, but these systems have not met the expectations, one explanation being that knowledge is also constructed through joint experiences, thus embedded in a social context (Jacobsson and Linderoth, 2010; Newell *et al.,* 2006). This makes PTS an interesting case to study, when functioning as a resource with both technical and organisational features, enabled via ICT and social networking, with the purpose of knowledge integration within single projects and on national level to improve the design process.

The paper explores the role and function of PTS in the design process of hospitals in Sweden, including how (if) it supports the design process. Accordingly, the aim of the paper is to investigate the embedding of the inherent knowledge of the PTS standard framework as one resource and how this affects integration and implementation in the design process, and the outcomes thereof. Three research questions are explored to fulfil the aim: i) How is PTS exploited as a resource to facilitate knowledge integration in the hospital design process in the various regions? ii) What are the outcomes from using PTS as a resource in the design process? iii) How is knowledge integration facilitated across the regions via the use of the PTS standard framework?

PTS

PTS as an ICT system was developed in the early 90's by the Jönköping region. The region is the main responsible for the system. The development was mainly driven by the incentive of creating a framework within the region that provided guidelines for incorporating spatial requirements connected to the early phases of the design process. Later, in the early 2000's, when shifting from providing illustrations and guidelines in binders to a web-based interface of the system, multiple adjacent regions to Jönköping joined PTS. As a result, PTS became an ICT-system and the 'PTS Forum' that serves as a network for knowledge and experience exchange among regions. The ICT-system mainly revolves around the availability of 3D models of 272 standard rooms of varying complexity (i.e., ranging from common areas to operating and radiology rooms) and guidelines with related spatial requirements connected to these rooms. PTS Forum revolves around a few meetings per year for discussion and updates on the requirements connected to the standard rooms, e.g., guidelines, spatial requirements. The meetings gather representatives with different roles and not only facility managers, such as subcontractors, BIM experts and procurement managers from the

different regions. The suggestions for improvements that are decided on the joint region meetings are handed over to PTS's national system administrator and PTS's national requirement analyst at the Jönköping region, and ultimately translated to updated requirements in the ICT-system by the ICT supplier responsible for development and management of the it-system. PTS Forum also hosts a web-based forum where users can ask for advice regarding design from other user of PTS, who can share their knowledge.

Consequently, the objective of PTS in the form of the ICT system and the professional network of PTS Forum, is to facilitate cross-regional knowledge and to integrate that knowledge to continuously improve PTS as a tool to support the design process in early stages. However, the use of PTS faces multiple challenges and PTS has not met the expectations of improving the design process in individual projects and in the different region's work processes. Specifically, the challenges in facilitating of knowledge integration across projects are addressed. The concept of knowledge integration (KI) has been studied in different theoretical and empirical contexts, ranging from organisation theory, product development, information systems, project management and human resource management (Berggren *et al.,* 2011), including construction (e.g., Hastie *et al.,* 2017; Ruan *et al.,* 2015). What the concept knowledge integration entails differ with at least 30 different definitions, and regarding what the process of KI consists of, there are also some differences: "KI as sharing or transferring knowledge, KI as use of similar/related knowledge and, KI as the combination of specialised, differentiated but complementary knowledge" (Berggren *et al.,* 2011, p. 24). In this paper, the industrial network approach (or IMP approach) is used as the theoretical lens to explore knowledge integration as intertwined with the development and use of various resources in interaction processes. Resources are crucial enablers of various activities and provide reasons for interaction among various actors (e.g., Håkansson and Snehota 1995; Håkansson *et al.,* 2009). From this follows some important notions regarding resources. First, no organisation possesses all the necessary resources, such as technologies and knowledge, in-house and inter-organisational interaction is thus a means to access, develop, adjust, and combine resources across organisational boundaries.

As such, inter-organisational interaction through business relationships is a central activity for firms to get access and relate to resources and activities of other firms, and relationships are thus important resources in themselves (Gadde *et al.,* 2003, Håkansson *et al.,* 2009). Second, resources are heterogenous, which means that the value of a resource depends on the way in which it is combined with others (Penrose, 1959). The same resource can thus have various roles and functions in different settings, and a resource does not have a given value - it is the service that the resource provides, through its relation to other resources, that provide a specific value in a specific setting (Håkansson and Waluszewski, 2004; 2002). Outcomes in relation to resource combining and the value of a resource can be distinguished in the form of: i) direct effects for the organisations that are involved in the development and production of a resource, ii) indirect effects in the development and production of a resource, iii) direct effects for the organisations using the resource, and iv) indirect effects from using the resource (Håkansson and Waluszewski, 2004). Third, resources relate to each other in resource constellations in space and time, crossing the boundaries of individual organisations and the content of these resource constellations develops over time when actors make resource adaptations, introduce new resources,

and/or eliminate existing resources (Håkansson and Snehota 1995; Håkansson *et al.,* 2009).

Fourth, resources are classified as either physical, reflecting material or technical resources, such as physical products and facilities (factories, machinery, information systems etc.), or organisational, reflecting social and organisational resources, such as organisational relationships or organisational units (departments, business units, teams, individuals etc.) (Jahre, 2006; Gressetvold, 2004, Håkansson and Waluszewski, 2002). One notion is particularly important, knowledge as a resource is not considered a resource type in itself, instead, knowledge is regarded as an integrated part of these technical and organisational resources (Håkansson and Waluszewski 2007). From this follows that knowledge integration is accomplished through interaction processes in the combining of resources, technical and organisational, that in turn, will generate new knowledge manifested in existing resources and/or the development of new resources.

METHOD

To advance the understanding of how knowledge integration is enabled through the joint use of PTS as an ICT system and the relationships between the various actors involved with PTS Forum, a single qualitative case study was conducted. Qualitative case studies provide depth, detail and richness of data and have proven to be a fruitful approach for studying phenomena of interaction processes (Dubois and Araujo, 2007; Easton, 2010), This allowed for capturing a phenomenon where it was critical to understand the dynamics of the social context (Halinen and Törnroos, 2005). Data collection consists of semi-structured interviews connected to the different regions. The interviewees consisted of 14 facility managers and 2 property managers in 7 regions and 1 facility manager from the region not part of PTS, as well as the PTS's national system administrator responsible for maintenance and coordination with PTS in the Jönköping region.

The main strategy for identifying and selecting the interviewees was based on individuals that interact with PTS, either using the ICT system and/or engagement in the inter-regional PTS Forum, thus approaching PTS members in the data collection. The interviews captured current work processes, how healthcare staff are involved in the design process (e.g., study visits, using different information medias) and information flow through projects (e.g., learning from previous projects, documentation).

A particularly important aspect was to capture how the knowledge integration on a regional level between healthcare staff and facility managers in different projects translate to national guidelines and recommendations via PTS. Altogether, the empirical data illustrates how PTS is used in the design process in different regions, how the utilisation of PTS relates to the work processes of individual regions, who is involved in the interaction via PTS, and individuals' perceptions of using and interacting with PTS. The data was analysed by making use of the theoretical framework in line with the research questions as to guide the analytical process aiming at fulfilling the aim of investigating how PTS as a resource could potentially act as a linkage in terms of knowledge integration between the various regions, including the Jönköping region where PTS originates from and who has the integration responsibility on a national level.

FINDINGS

The perspectives of facility managers in the use of PTS within different regions
One important aspect in the design process in early stages is the involvement of users (i.e., healthcare staff) (or not) in the work procedures to transform the knowledge of medical operations into accurate building requirements. Most facility managers expressed that in the established workflow processes there is an overall challenge of involving users whilst also considering the requirements of the facility managers that must be met.

As a result of this, many facility managers explained how they often face the issue of unintentionally creating false expectations related to the level of influence users believe they have during the design process. Considering this, spatial requirements provided by PTS has proven to be useful as means of facilitating decisions when current workflow processes are insufficient. A facility manager described how the level of PTS integration is dependent on the level of organisational processes:

> "There is a need to coordinate and have solid processes within the region to include the users (healthcare staff). Otherwise, one runs the risk of implementing PTS incorrectly and an effect of that would be causing the projects to be perceived as more unstructured than they already are. It is important then to consider to not oppose the organisational culture, especially if it is already working."

Related to making changes within the regional organisation to use PTS more in the design process, and, in affecting the development of PTS many facility managers expressed the difficulties in influencing the design requirements, with representatives from the smaller regions experiencing not feeling included. The larger regions, with some being among the first members of the PTS Forum network, there are different processes for different type of projects, with project scale being the key distinctive factor: larger project often involves architects and generating user-influenced spatial requirements whereas smaller projects tend to be design reviewed by the facility managers themselves, as they often have a background as architects. A facility manager from one of the larger regions explained how using PTS more for design review purposes could help facilitate user-involvement in a project more clearly rather than the current more complementarily role PTS had for them:

> "The gap of spatial understanding emerging between actors who typically have a design background and non-design actors (users) can often be translated to change order. Using PTS 3D models could potentially help us mitigate changes done after commission."

In this context, the facility manager from the region that is not part of the PTS network, expressed how their region's decision to not join the PTS network is primarily based on relying on the current intra-regional work processes they already use. The local adaptions in such work-processes conducted by each region differs:

> "It (PTS) is a good template to begin with and it advantageous when it is nationally established. However, there is a difference in organisational culture among the regions and the level of local changes conducted, creating a gap in terms of local changes between each region using PTS. Consequently, this affects how the spatial requirements are generated among the different regions."

Connected to the process of generating spatial requirements was, according to many facility managers, the challenge of using multiple disciplines in the PTS It-system. Specifically, facility managers experience, particularly in larger projects, that the PTS ICT-system crashes due to the component responsible for generating documents from the database is not capable of handling large dataset, resulting in system crash. Lastly,

some facility managers described how their access to the PTS database is not shared with other project members due to sign-in access being limited to facility managers when there are no projects. As a result, actors such as architects tend to stick with their own standards that are not PTS and gaining access to the it-system and room functional programming documents once these have been generated by the facility managers themselves.

The perspectives of the PTS national system administrator and property managers
As described by the property manager in the region responsible for PTS, PTS initially started out as a regional cross- region knowledge integration in the early 90's. with the most recent members having joined in recent years. These regions who have only recently joined had according to the property manager internal workflow processes that worked well, something the property manager evidently observed:

> "Those who were last to join PTS already have a solid work process and have "yet" to see the benefits it (PTS) provides. Some expressed prior to joining that they wanted to partake in the requirement set by PTS and saw it as incentive to join to gain access to these requirements."

This discrepancy in how much PTS is used by the different regions is something the property managers believe is rooted in the work process culture. More specifically embedded in current work processes and the ability to set the right conditions for integrating new work processes and the size of each region being an influencing factor, with smaller regions having less demand for building more, thus causing less sense of urgency for change within the established work culture:

> "It is a cultural question. It does not matter if one uses PTS or something else. The larger organisations tend to differ in terms of work processes for different projects, causing a drift in creating a "common working culture". Smaller regions on the other hand tend to build to a less degree making them more reliant on PTS for setting requirement, although we have encountered challenges within these regions in terms of using spatial requirements provided by PTS more rather than their own."

PTS's national system administrator also described how they experience that the regions can at times limit themselves with the degree PTS is used, with the organisational culture being a limiting factor:

> "It is important to ask oneself whether it is the organisational culture dictating the level PTS is integrated (or lack thereof) or how PTS can influence the organisational culture and thereby create conditions for knowledge integration."

Also, they have experienced a growing enthusiasm in the workshops conducted a few times per year where representatives from every PTS involved region participates to create the basis for PTS spatial requirements.

DISCUSSION

Knowledge integration within and across regions
Looking at how PTS is exploited as a resource by the various regions and how knowledge integration is facilitated (or not) using PTS, analysis identifies the following aspects as crucial: challenges from organisational culture, processes for follow-up work and involvement of healthcare staff in the design process.

Specifically, organisational culture, according to both those developing PTS and facility managers, needs to be considered when integrating a technical standard framework as to combine the framework knowledge with existing resources. As such, the usefulness of a technical resource is contingent on how it is "activated" in the combination with other resources, where organisations play a crucial role in terms of

inherent knowledge (Håkansson and Waluszewski, 2002), creating a technical-organisational interface (Jahre *et al.,* 2006). The established resource constellations and work processes are outcomes of how the design process for previous projects have been conducted, leading to organisations building up knowledge from previous experiences.

The experience feedback-loop and workflow processes from previous projects is then leveraged in new projects, which can potentially lead to project members relying rather on cross-project knowledge within the region than knowledge gained from cross-region knowledge integration as intended with the PTS Forum. Consequently, this influences the regions' perception on the value PTS provides, as resources are allocated in relation to existing work practices and routines, that are "already working". This view on PTS is further affected by what facility managers expressed as inability to influence PTS requirements that are revised and discussed during the yearly workshops and conferences.

Despite the intention of using the input from the regions for development of PTS to improve its usefulness as a resource, regions' representatives, especially smaller regions, or regions that have recently joined PTS, felt that neither did their input matter, nor did PTS organisation encourage the interaction. Due to these conferences and sessions being one of the primary ways for regions to provide feedback back to the PTS organisation, it can be argued that it is important to further explore how the feedback and knowledge emerging in these forums is later integrated into the PTS requirements as part of the development and further improvement of PTS to increase its usefulness, which is crucial for value creation. As such, the value of the resource both from a technical and organisational aspect is hampered by the lack of interaction (Håkansson *et al.,* 2009).

This sense of not feeling involved in the PTS process was also expressed by users (e.g., healthcare staff), as mentioned by some facility managers. When conducting design review sessions with users who typically have a lack of spatial understanding (e.g., healthcare staff) via 2D drawings, the ability (or lack of) to accurately review and provide feedback on the design becomes a key factor. Moreover, when most projects in a region are conducted via 2D drawings, the 3D based standard rooms with connected spatial requirements provided by PTS cannot be used to the extent that would have otherwise been the case, if reviewing via 3D models had been the norm.

However, even the regions that conducted design reviewing primarily via 3D models expressed concerns over the provided PTS 3D models in terms of lack of standard room intended for advanced healthcare operations (e.g., radiology room, surgical room) and outdated models that require revision, resulting in longer project lead times. Independent of information medium used for design review, there appears to be a lack of a structure for a feedback loop between users and facility managers in place, which hinders the development and use of PTS. There is a lack of established processes for following up and validate the feedback provided by users in early phases in the later phases. The absence of resource interfaces and lack of interaction is thus a barrier for knowledge integration between users and facility mangers, and thus also between the regions and the PTS organisation. Relational interfaces then play a crucial role for development of resources as to enable an increased value creation for different users (Andersen and Gadde, 2019).

A side-effect of these barriers is the need for alternative processes for leveraging user knowledge, such as study visits. Several regions, differing in both organisational size

and length of time connected to PTS, have made many study visits to adjacent regions with the ambitions to generate enthusiasm among the healthcare staff to feel included and help facility managers better understand how others have approached projects similar to what they planned to build. However, facility managers also acknowledged the difficulties: lack of structure for documentation of learnings and difficulties with knowing what parameters to look for during the visits to make accurate comparisons. PTS could potentially mitigate the number of visits if the framework had a higher technical standard and could meet the requirements of usefulness as to exploit the knowledge in PTS.

Another factor affecting how much PTS is utilised is the lack of complex standard rooms available in the PTS database, e.g., radiology rooms, surgical rooms. Many of the facility mangers expressed how this absence caused a challenge in how to use PTS in the projects due to many regions already having their own database for less complex rooms (e.g., waiting room, reception desk), often with the same functionality in smaller hospitals, thus relying on their own database rather than the standard rooms available in the PTS database. Moreover, the sign-in access to PTS is bound to facility managers and not to other project members (i.e., architects) during times when there is no project. This hinders incentives for architects to become involved in the process of generating the early spatial requirements together with the facility managers and thereby contribute with producing accurate requirements, reflecting the wants and needs of the healthcare staff.

The PTS forum's role for national knowledge integration

One important result is the significant importance of organisational culture. It could be argued that this is mainly because both property managers and the national system administrator are not necessarily involved in the building projects and PTS Forum being their closest relationship with the regions, thus explaining the absence of technical aspects in knowledge integration between them as an organisation and the regions. The knowledge integration is intended to be manifested in the PTS Forum and workshops conducted. Discrepancy emerges in how these sessions are experienced and valued, with regions expressing that an increase in the number of workshops and conferences would be desirable, and smaller regions even experience exclusion. The national system administrator identifies a need to scaling up PTS Forum as to encourage increased interaction with the ability to influence future development of PTS, independent of regions' size.

CONCLUSIONS

The study investigates how the inherent knowledge of the PTS standard framework is integrated and implemented in the design process, and the outcomes thereof, including how (if) PTS facilitates knowledge integration among resources within and across Swedish regions. In conclusion, the findings of the study shows that the potential of PTS as a resource for knowledge integration is not exploited to its fullest, due to the lack of embeddedness into existing technical and organisational resource constellations. PTS is used to various extent in the different regions. Jönköping region is in the forefront of using PTS, which can be explained by the fit of the technical and organisational resources within the region, that in turn is an outcome of that Jönköping also has the development of PTS, thus, development and use of PTS go hand in hand with other technical and organisational resources in the region, which improve the resource utilisation and enables exploitation of embedded knowledge. As a comparison, regions with little digital competence, thus, 2D drawings still rule the

game in the design process, cannot exploit PTS, as the technical features cannot be exploited due to the lack of digital technical knowledge in the organisational units of the regions.

But the membership for these regions in PTS can cause indirect effects in the development of digital competence: a driving force to take the leap from 2D to 3D. This would, however, require investments in new resources, such as BIM coordinators to facilitate the technological change within the region. Furthermore, utilisation of PTS is also deterred as some of the organisations, such as architects contracted by the region, in the design process do not have a direct interface to PTS, which hinders knowledge integration from these organisations. Hence, a first conclusion is that within each region, resource combining of technical and organisational resources must be improved to reap the benefits of using PTS. Embedding PTS in a regional setting requires a certain technical and organisational maturity.

A second conclusions is that in terms of outcomes, PTS today functions mainly as part of the set of requirements and/or as a validator in the design process to verify the value of other resources in the form of 2D-drawings and 3D-models. A conclusion is that to develop PTS further and increase the utilisation of PTS, more interaction would be needed among the regions. This would improve the development of PTS and align with the users' needs and processes, thereby increasing the value of PTS. Today, the lack of interaction results in individual regions developing their own processes and room prototypes, instead of exploiting the potential of standardisation across regions.

Thus, PTS as a knowledge carrier must be supported by more, and in depth, technical and organisational interfaces to leverage and combine the regions' resources and knowledge for hospital design. This would enable a more sustainable use of hospital construction project resources on a national level as PTS could guide the design process and create imprints in hospital buildings across Sweden. By gaining an increased understanding of the criteria required for fully utilizing PTS, a more accurate comparison with a non-Swedish hospital standard could be realised. Knowledge and experience connected to healthcare facility projects could then potentially be utilised beyond a Swedish context. This would help understand how a best-practise approach to healthcare facility planning could best be achieved.

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