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Digitalization Enables User-centric People Flow Planning in Smart Buildings



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Abstract

Traditionally, building systems such as elevators and access control have been developed independently of each other. Furthermore, the role of manufacturers in their value networks has followed a self-reliant logic, creating a highly fragmented business environment in which building systems are competing against parallel systems from other providers. However, rapidly increasing customer requirements in regard to smart buildings are challenging this practice. Digitalization is revolutionizing both the technological solutions and the way of doing business because it enables the integration of multiple building systems for increased value from the customer's perspective. However, moving towards integrated solutions requires a clear vision of what generates this augmented customer value. One way to address this complexity is to focus on the users of the building, to integrate all the building systems that are relevant to the flow of people. This user-centric approach creates new value and reduces complexity in smart buildings.

Keywords: Building Systems, Digitalization, Integrated Solutions, People Flow Intelligence, Smart Building

Introduction

Smart buildings face ever-increasing requirements, driven by at least three global megatrends. First, along with the urbanization of living, buildings are becoming taller. Second, aging people in developed societies want to live in their own homes for longer. Third, the requirements for environmental sustainability call for new solutions that improve building-specific energy efficiency. The combination of these three trends makes it obvious that buildings must continue to become smarter in the future.

In parallel to the developments described above, digitalization has emerged as a new global megatrend. Digitalization is known to enable the integration of multiple products or larger systems, which has fundamentally changed the value-creation logic in many industries. Many smart building systems have been digitalized, and there is a promising value-creation opportunity to develop new integrated solutions by combining multiple building systems. However, certain segments in the construction industry have been surprisingly slow to leverage this opportunity and therefore the intelligence in buildings has not progressed as quickly as expected, especially if measured by the interaction between various building systems. One explanation is the long history of creating specific building systems for specific needs and establishing manufacturing industries for these systems. This has resulted in both fragmented building systems and fixed structures within the construction industry.

Unleashing the potential of digitalization in smart buildings requires a clear definition of what to integrate, because new integrated solutions must be worth the effort of breaking the traditional silos within the construction industry. As it seems that the incremental development of existing building systems is not going to create sufficient new value, the focus needs to shift from technology to people. The objective of this paper is to examine how the new integrated building systems can be designed based on the needs of building users. The chosen approach is to define the building systems that users need when traveling from the main entrance of the building to their final destination, which may be, for example, an office or an apartment. This user-centric people flow planning is one example, how the emerging trend of Internet of Things is impacting smart buildings.

Previous research suggests that instead of asking what products customers want, providers would do better to ask what they want the products to do for them (Ulwick 2002). When asked what building users want from buildings, one thing they seem to appreciate is a smooth journey through the building. Also, user interfaces to building systems need to be intuitive and unified so that there is no need to learn to use multiple systems separately. The most relevant building systems for users include those needed to access the building, to navigate

to the right destination, and to search for information required during the journey. In addition, it is appreciated that all equipment is systematically monitored for safety.

This paper contributes to the current understanding of the value embodied in integrated building systems by separating the value-creation and value-capture dimensions. In other words, the building user experience is used as a framework for creating new value, which is then captured by implementing new integrated solutions that make both functional and commercial sense for all stakeholders in the smart building environment.

The paper is structured as follows. The next section focuses on digitalization as an enabler for building system integration. After this, we discuss how the fragmentation of the construction industry slows down the pace of smart building development by complicating the integration of building systems. Then we move on to presenting a user-centric approach for the planning of integrated solutions, driven by people flow planning. The benefits of this approach for stakeholders of smart buildings are then presented. Finally we describe the new phenomenon of using consumer products as part of building systems and draw conclusions.

Digitalization Enables the Integration of Building Systems

The construction industry has a long history, and building systems have seen many development cycles. Most systems began life as mechanical products, with some electronic control capabilities added in later phases. When it comes to control systems, analog has been replaced by digital over the past few years. This trend of digitalization is very important, because it enables the effective separation of the control logic from the physical equipment. For example, elevator control can be separated from the elevator car, or access control logic can be separated from physical readers and locks.

This development opens up totally new possibilities, because as soon as the control can be separated from the physical equipment it is also possible to combine the control of multiple systems. For example, if access control is combined with elevator control, both of these can be further developed as a single entity. This kind of integration, which is enabled by the digitalization trend, is well known from many consumer products. For example, a smartphone is a combination of many



Figure 1. The multiplicity of individual building systems. (Source: KONE)

integrated products and functionalities, such as a phone, camera, and web browser. There have not been many similar examples within the construction industry, but the benefits are so obvious that over time the barriers between building systems will be increasingly removed. This will fundamentally change the way buildings function, how new value is created, and how buildings are perceived by their users. To date, most smart building innovations have focused on improving the eco-efficiency of new construction. This development should be complemented by user-centric innovations to make the smart-building value proposition strong enough to also justify bigger investments in the modernization of existing building infrastructure. However, as digitalization enables the integration of new building systems, it can also easily make the offering more complex. Managing this complexity requires a vision of where the company wants to be in terms of the new offering (Mocker 2014).

Challenges With the Fragmentation of the Construction Industry

Smart buildings contain many building systems, including the elevator system or access control system, each consisting of one or more products. Some products include intelligent control capability and some of them have connectivity. These kinds of smart and connected products have been studied extensively. One study suggests that smart and connected products are transforming competition by disrupting value chains (Porter 2014). Companies need to rethink their strategic choices and create new ways of working with existing and new partners.

In many cases, the basis of competition moves from discrete products to broader systems. In the smart building context this means moving from standalone building systems towards integrated solutions that are created by integrating one or more building systems. However, the way organizations in the construction industry operate does not provide the best possible starting point for new integrated solutions, especially those that require solid planning of the user experience. There are three big challenges that need to be addressed: 1) the fragmentation of building systems, 2) industry players working in their own silos, and 3) the fact that different building systems are implemented sequentially, independent of each other, during the construction of a smart building. We will now address these three challenges in more detail.

First, when taking a closer look at buildings we find multiple building systems, such as elevators, escalators, access control, heating, ventilation, air conditioning, and many more (see Figure 1).

All the aforementioned building systems have been designed to meet a specific requirement – for example, to provide conditioned air, access control, or transportation of people. They have been developed over time to provide new functionalities enabled by technological innovations. For example, in the elevator industry, travel speed, space efficiency, and ride comfort have steadily improved. Furthermore, every now and then bigger innovation steps are taken – the machine room-less elevator introduced in the 1990s being one good example. So, building systems have been improving in terms of functionality and performance, but predominantly within their own functional

silos. In other words, elevator systems have been competing against other elevator systems, access control systems against other access control systems, and so on. It seems that the whole construction industry has been organized according to functional building systems and very little has been done to make these solutions work better together, or to provide any cross-functional capabilities. For building users this fragmentation means several separate systems all with different user interfaces. In the absence of integrated systems that adapt to their needs, building users are instead forced to adapt to the technology and learn each system one by one.

Second, the fragmentation of building systems has also contributed to the fragmentation of the roles of their manufacturers. Over time, the construction industry as a whole has adapted to the situation, with building systems being purchased, installed, and maintained separately. This practice has led companies to seek out new value in building systems dimension and organize themselves accordingly. Professions such as elevator sellers and buyers, and access control sellers and buyers have been established. This development has further isolated building systems from each other, making it even more difficult to implement anything cross functional. Furthermore, weak or missing standards defining both interfaces and functionalities between multiple building systems raise the threshold for leaving the established product-oriented businesses even higher. In addition to some widely used protocols and interface specifications, no functional specification for smart building exists that would be sufficient for companies to create their own solutions and then connect them with those of other companies to form a seamless user experience.

Third, in addition to the technological and organizational barriers existing in the construction industry, the way building projects are organized in many phases also prevents various building systems from working together better. Constructing a large building can take several years. This can result in huge time lags between, for example, the elevator installation and the phase in which the access control solutions are installed. Because of this, it is easy to consider these building systems as separate, with no common dependencies. However, despite their timing differences, both elevator and access control systems need to be planned together and, once installed, must work together as a part of an integrated solution.

A User-Centric Approach to People Flow Planning

As discussed above, digitalization enables integration of multiple building systems. The prevailing challenge is to define what to integrate in order to maximize the customer-perceived value of the systems. The objective is to create smarter buildings, but the starting point is very fragmented – there are tens of building systems from numerous vendors, and the level of standardization is very poor. As each building system is specified separately, unified functionality cannot be expected. Furthermore, the number of different systems makes it almost impossible for any company to assume the role of overall integrator for all systems. However, companies with the ability to identify the right integration strategy will develop sustainable differentiation capabilities, separating them from their competitors (Cusumano 2011).

When it comes to defining new solutions that create more value for customers, an approach based on improving the customer experience is widely accepted (Davies 2004). Moreover, it is suggested that products and services will become commoditized and the customer experience will be paramount. This development is described as a move towards an experience economy (Pine & Gilmore 1998). This is straightforward thinking in many consumer businesses, where the value of the product is determined by its user, who is also the customer. However, in the construction industry the interesting question to ask is 'Who is the customer here?' In other words, whose experience is supposed to drive the development of building systems? In fact, there are different stakeholders in different

phases of the lifecycle of a smart building, such as developers, architects, construction companies, and facility managers. And then there are the building users, who also interact with multiple building systems but have very little to say when it comes to the purchasing decisions of said systems. Given the increasing amount of technology being used in buildings and the dependencies that exist between them, the importance of a human-centric approach will most likely grow, necessitating careful user-experience planning.

Solutions that are relevant for the smooth flow of people within buildings make an interesting case in terms of integrated building systems. These are called people flow solutions, and the control logic is called People Flow Intelligence. The main idea behind people flow planning is to make the user's journey from the building entrance to their final destination – which may be, for example, an office or apartment – as smooth and smart as possible. Along the way there are physical products, such as doors, access gates, elevators, and escalators, each representing a traditional building system (see Figure 2).

Traditionally, distinct building systems have been designed separately as discrete product offerings, but the user-centric approach to people flow calls for creating new value through integrated offerings. This changes the design approach. Rather than starting from the technology, the key question is how to optimize the user experience – the role of technology is then to enable the required solutions. This may sound obvious, but surprisingly many building solutions are still very technology driven, and building users are



Figure 2. A vision of a smart building's people flow consisting of integrated building systems. (Source: KONE)

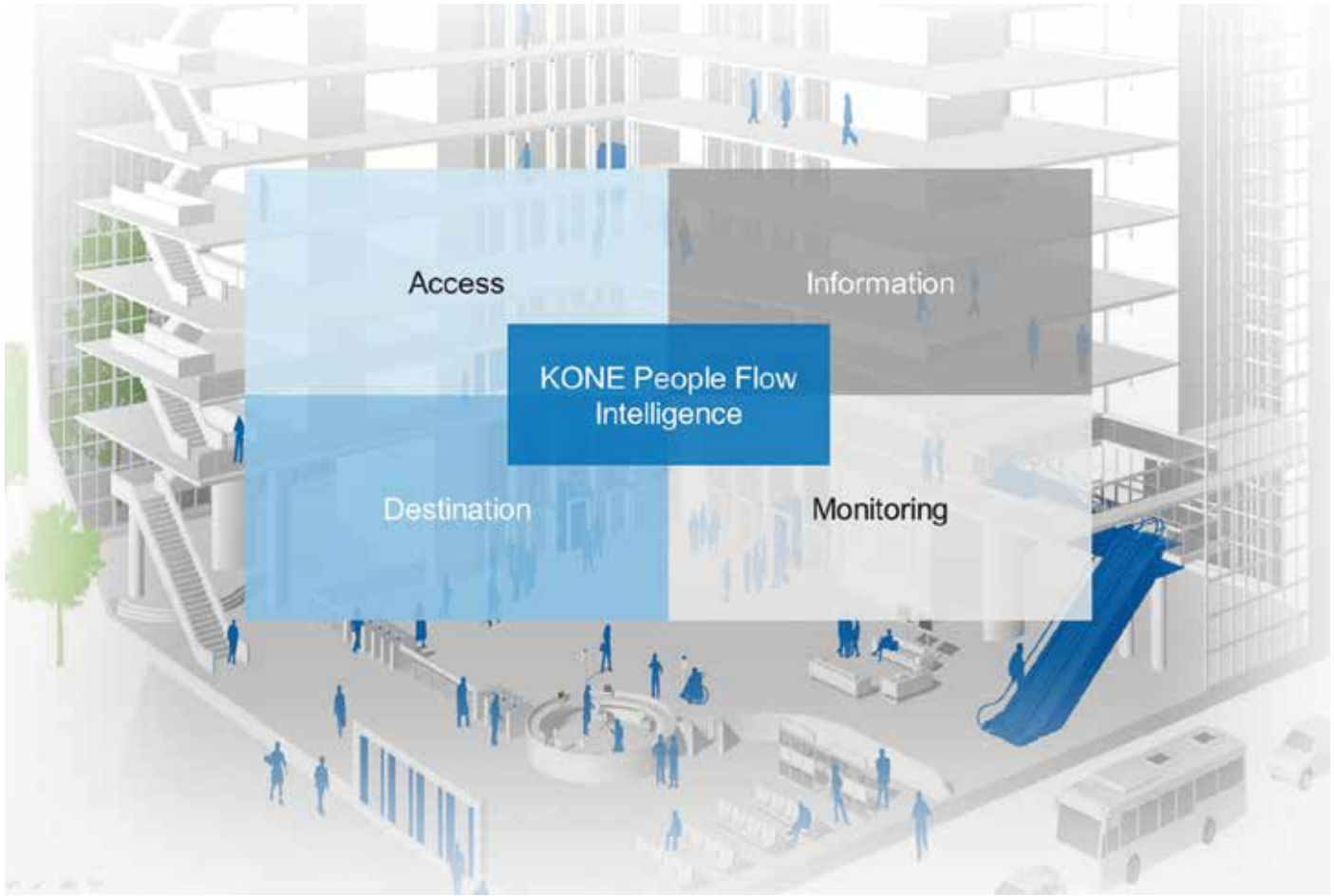


Figure 3. The building systems required for an integrated people flow solution. (Source: KONE)

faced with the challenge of having to learn to use all of them correctly.

The people flow solutions that are relevant from the user's point of view can be grouped into four domains: access, destination, information, and monitoring (see Figure 3).

To ensure appropriate building access according to user identity, access control systems are needed. Elevator destination control solutions make it possible to travel to the desired destination easily and with minimal waiting, also helping to optimize elevator capacity. During their journey through the building, users typically need a lot of information provided, for example, via screens inside the elevator car or elsewhere in the building. Monitoring solutions are needed to ensure safe, reliable, and effective operation of all the aforementioned products and solutions. When all these building systems are designed together as a unified solution that focuses on the user experience, significant new value can be created. However, in order to deliver the best possible functionality, the solution architecture must remain open so that systems from multiple vendors can be integrated. This calls for companies with a strong user-centric vision and the capability to integrate the required systems. Once implemented, this change in approach can

provide an opportunity to move part of the focus from optimizing the upstream activities – such as sourcing, production, and logistics – to downstream activities aimed at improving the customer experience (Dawar 2013).

The construction of a smart building can take several years, meaning that the building systems needed for smooth people flow are implemented at different phases of the project. Despite this, once installed they need to perform according to a common specification. This means that the people flow planning must take place very early in the construction project to take into account the required building systems for a seamlessly integrated people flow solution. In practice, the elevator system is typically one of the first to be specified, so it provides a natural starting point for people flow planning. Elevators, escalators, turnstiles, and doors are then integrated by shared destination control and access control. Planning these building systems together requires a totally new mindset. Furthermore, some industry players must assume the role of system integrator – otherwise the process from initial design phases through to final installation and commissioning of an integrated solution will not deliver the desired results. People flow planning is like quality – it must be taken into account from day one and remain on the

agenda for the duration of the construction project. It is impossible to add smooth people flow to the complete building at a later stage.

Benefits of User-Centric People Flow Planning

From the user's point of view the benefits of user-centric people flow planning are obvious, as moving around within buildings becomes smoother. However, building users are typically not part of the decision making process when construction projects are being planned and executed. As a result, the value of people flow planning must be clear for the stakeholders that are making the key decisions. According to one study, companies that can perfect the complete experience during and after the purchasing process will reap big rewards (Rawson 2013). When it comes to smart buildings, the definition of the customer must be extended to cover developers, architects, construction companies, and facility managers, as they all play a role in a building's lifecycle.

Developers drive the planning phase of the new development. For them, unified people flow planning provides three main benefits. First, the new building will have

more value in the eyes of potential tenants: it will be operationally effective, have a unified design, and be pleasant for its users. Second, it is easier for developers to deal with one company that can provide an integrated people flow solution rather than several companies that each provide a separate building system, with no one taking care of final integration. Third, an integrated people flow solution package is easier to connect to building management systems than several non-integrated building systems. Finally, other external interfaces can be designed for the overall solution rather than for its separate components. However, the architecture of integrated solutions must be modular and open to enable the use of the best possible building systems from different vendors.

Architects are the key stakeholders in the design phase. For them, the functionality and visual appearance of the building are highly important factors. Holistic people flow planning addresses these needs because the entire integrated solution and its features can be planned before construction work begins. This brings multiple benefits in terms of seamless functionality and visually consistent design (see Figure 4).

Construction companies need to execute very demanding projects in order to fulfill the building specification, typically under tight budgetary constraints. The more building system vendors there are, the more challenging this task becomes, as the effort of managing the vendors increases. It is beneficial for the construction project if one vendor takes care of the wider solution entity and assumes responsibility from the early planning stage until final delivery and commissioning. An integrated people flow

solution serves as a good example of this, because when one company integrates all the people flow-related building systems and provides them as a single package, the number of vendors decreases and the whole construction project becomes easier to manage. These pre-integrated solutions also reduce costs, because they cut down the amount of expensive on-site integration work. There are also benefits in terms of quality, because one-time integration work on site is more prone to failure than productized integration work in factories.

Facility managers are present in the building for its entire operational lifecycle. For them, operational effectiveness is very important, and they also need consistent maintenance support for the building systems. When all people flow-related building systems can be handled as a single entity, it is much easier to plan maintenance activities. Every now and then, buildings are subject to changes that must be executed without disturbing daily operations. For facility managers, an integrated people flow offering is superior to separate building system offerings because they have fewer companies to deal with. Solutions delivered as larger integrated entities ensure that responsibilities remain clear.

Using Consumer Products as Part of Building Systems

The construction industry as a whole is very business-to-business oriented. However, one important measure for any building is its ability to serve its users, and in too many cases this basic requirement does not receive the attention it deserves. As building systems are developed in their established technology

silos, it is often forgotten that users perceive the building as a holistic entity rather than a collection of individual systems. Nonetheless, many landmark buildings still have a strong technology orientation, meaning that building users are forced to learn multiple ways to control the building's various functionalities. The number of separate control panels and user interfaces can be staggering.

Traditionally, the construction industry has trusted industrial technologies rather than the mass-market technologies used in the consumer industry, which are perceived as unreliable and not suitable for applications with long lifecycles. This mindset has certain historical merit, but has changed in many other industries as the boundaries between industrial and consumer-oriented solutions have become more and more unclear. In the past, industrial applications typically drove new innovations, which were then also implemented in consumer businesses; today, the situation is often the other way around. Mobility solutions and tablet computing are particularly good examples of this change. Both have achieved high sales volumes in consumer applications and developed functional reliability to a level that lower-volume industrial solutions cannot easily achieve. This paradigm shift can also be used to improve people flow planning. Rather than developing new handheld devices, the preferred approach is to develop applications for the smartphones that people are already carrying. This also opens up the opportunity to personalize services, which is a relatively new approach in the construction industry (see Figure 5).

Another development is to use screens similar to those already established in tablet



Figure 4. Seamless integration of building systems into a people flow solution. (Source: KONE)



Figure 5. Elevator functionality integrated into a consumer device. (Source: KONE)



Figure 6. A consumer technology-advocated user interface. (Source: KONE)

computing, instead of developing specialist touchscreen displays for elevator control (see Figure 6).

These applications blur the line between consumer products and industrial solutions, providing a totally new platform for innovation. For users this is a fantastic development because they want to use their devices for as many different purposes as possible, and for them the border between industrial and consumer applications is an artificial one. One good example of this is the elevator control application implemented on an iPad (see Figure 7).

This development makes a great deal of sense for building users, who can have the same user interface on their own devices and in the building environment. The construction industry as a whole also benefits because it can reap the rewards of the rapid development of technologies driven by the fast-paced consumer industry.



Figure 7. Integration of building system functionality into consumer devices opens up unlimited possibilities. (Source: KONE)

Conclusions

Along with the global megatrends that influence the ways buildings are used – including urbanization, the aging global population, and environmental sustainability – buildings must become smarter. Digitalization has already transformed many industries, and now it is the turn of the construction industry. As a result, many building systems will be integrated in order to deliver enhanced functionality. Because of the fragmentation of existing building systems and the established roles within the industry, it is difficult to fully leverage the obvious benefits of digitalization, and the adoption of new integrated solutions has been slower than expected. However, digitalization is inevitable. The sheer number of different building systems means it is important to find the most appropriate vision and a solid value proposition for integrating them.

To date, the strong technology focus has driven the development of building systems, but its capability to create new value is rapidly decreasing. This paper proposes shifting the focus from technology to people as the new approach to value creation. It also proposes that the integration of the solutions that are required for smooth and smart people flow within buildings increases their perceived value for building users. This change of mindset helps to create new value, which is then captured by new integrated people flow solutions. Such solutions not only benefit the users of buildings, but also other stakeholders such as developers, architects, construction companies, and facility managers.

Eventually, this development has the potential to raise smart buildings to the next level of value creation in terms of serving their users.

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