

AUTOPOIESIS & MOBILE TECHNOLOGY ADOPTION:

The case of wireless collaboration

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Abstract: Highly complex collaborative systems often present contexts where the use of wireless enabled technologies could provide numerous benefits. The adoption of such technologies has proved extremely difficult, however. This paper explores issues of technology adoption from an autopoietic perspective in order to explain the success and failure of two case study examples of wireless technology adoption. This discussion will be used to propose a new view on technology adoption for wireless collaborative systems

Key words: Autopoiesis, user adoption, collaborative systems

1. INTRODUCTION

To date the use of mobile communication technologies to assist individuals more efficiently undertake a collaborative task is growing at a rapid rate.

This paper will examine two case study contexts where the use of mobile collaborative technologies had been attempted with mixed results. The results, of this empirical work will be examined using autopoietic theory as a framework for understanding the dynamics involved with changing the work process to incorporate wireless technologies.

Autopoietic theory is a biological systems theory, that describes the rules and processes through which individuals relate to the environment, undertake cognition and develop language. It will be argued that if the implications of autopoietic theory are accepted, then the success of radical changes to collaborative business processes, involving wireless technology

require that the software, hardware and the existing work processes of the user are considered as a single system.

2. METHODOLOGY

The case studies involved up to 4 semi-structured interviews with users and developers of the systems. Subsequently a further four semi-structured interviews were conducted with construction site staff to ascertain their attitudes towards the adoption of new technologies on building sites. Interviews lasted on average for 1 hour, and a standard set of questions applied in order to ensure that the interviews covered the same key topics and issues. Interviews were audio recorded on a digital recorder and transcribed for subsequent analysis. A thematic analysis of the issues and benefits was undertaken.

3. CASE STUDY 1: RESTAURANT MOBILE ORDERING SYSTEM

The Restaurant Mobile Ordering System utilized mobile PDA technology in order for table staff to take orders for meals in the restaurant and communicate these orders with bar and kitchen staff. Prior to the introduction of the system, a 'traditional' restaurant ordering process had been employed. The waitress/waiter, using paper note pads, wrote down client's drink and meal orders. Initially, table staff would record drinks orders from clients and verbally passed these on to bar staff for preparation, before returning to the table with the order. On return, meal orders were taken by table staff and handed to the kitchen staff who would cook the meal. Table staff retained the original order with the kitchen receiving a carbon copy. When orders were ready a bell was rung and table staff would deliver the order to the client. On finishing the meal, the floor staff would present the clients with the bill and the payment process takes place.

The restaurant owner, in an attempt to improve customer service, decided to replace the hand written order taking process with a wireless network framework, incorporating the use of wireless enabled PDAs for the table staff. "What I really wanted to achieve was improved customer service. The table staff were spending too much time running back and forth between the bar and the kitchen when ideally they should be waiting on the customers.

The PDAs mean that they can stay on the floor for a greater percentage of the time” (Restaurant owner, 28/7/03).

The hardware underpinning the system included: “...wireless enabled PDA’s (personal digital assistants) which are used as a replacement to the order pads.” (Restaurant owner, 28/7/03) The PDA’s had an interface similar to the menus used by the customers with cascading screens allowing table staff to select the items for consumption, the quantity and any special requests to do with that order. The PDAs also allowed orders to be changed at any stage. “The PDAs connect to the restaurant’s wireless network through two wireless access points.” (Restaurant developer, 28/7/03) The wireless protocol utilized by this system is IEEE 802.11. This protocol allowed connectivity to a “printer located in the kitchen and the till system located at the bar”. “It also connects to a database server which stores all processed orders.” (Restaurant developer, 28/7/03). The software used on the PDAs was a proprietary package purchased by the restaurant and as such the basis of the system was created from an “off the shelf” product. As such, the base system, prior to adaptation and adoption by the restaurant, had undergone a rigorous (but generic) development process. Prior to testing the system, the manager “organized a meeting with all staff, including the table, bar and kitchen staff.” (Restaurant owner, 28/7/03). In this meeting the proposed system was explained to staff and they were given the opportunity to participate in the design process, providing feedback about any concerns with regards to the automating of their work and specific user issues which needed to be considered. It is important to note that the system was relatively uncomplicated, only requiring the development of an interface for the restaurants menu and order forms, and no further modification to the already existing systems of the restaurant.

The restaurant manager acknowledged that the system provided almost instant benefits to the business, with further unexpected benefits emerging over time. The benefits described by the restaurant owner and manager were as follows:

- Greater accuracy in the orders produced: “...we now have fewer misinterpretations compared with the written orders form.”(Restaurant owner, 28/7/03). This was achieved through the use of check boxes on the PDA interface with the consequence that there was less chance of misinterpretation by kitchen and bar staff (and therefore less incorrect orders).
- Improved record keeping: “...all orders are recorded to a database server”(Restaurant developer, (28/7/03) via the wireless network. There is no need to double handle the information, in the form of subsequent data entry from the hand written notes. This resulted in a reduction of recording time, associated cost benefits and improved data integrity.

- Improved customer service: The waiter / waitress no longer needs to physically move between the table service area and the kitchen or bar. This allows more time for waiting on the customer. It also has the added benefit of providing table staff a greater opportunity to sell more items such as drinks and desserts.
- A quicker response time to variations in customer orders: The use of the PDAs has also allowed for faster interaction between table staff and bar / kitchen staff. For example, “if a customer wants to know how their order is progressing then the waiter can make the query from the PDA and tell them more or less straight away.”(Restaurant developer,28/7/03),
Interestingly, the restaurant owner did not perceive any issues associated with the system’s introduction. “No, not really, in the beginning we only had two PDAs, which was not enough but now we have four which has addressed that.” (Restaurant owner,28/7/03)

4. CASE STUDY 2: MOBILE HOSPITAL WARD SYSTEM

The Mobile Hospital Ward System is being developed to access information in the patient records used by doctors on their ward rounds. The previous system required doctors to download information regarding a patient from the patient records of different departments (such as radiology or pathology) when appropriate. These documents were downloaded to create a paper-based hard copy, early in the morning prior to the doctors conducting their rounds. A number of collaborators could contribute to the patient record including several doctors (various specialists as well as the attending doctor), nurses, different medical departments as well as other medical consultants such as physiotherapists. It is important to note that there was no shared database between these collaborators and each was able to update information in the patient record at any point in time. This created a problem, in that if an update was made whilst a ward round was in progress, the doctor would not have access to that information until the end of the round, which could take up to 3 hours. The potential therefore existed for the doctor to make an incorrect / uneducated diagnosis in the absence of the most up to date information.

To address this issue, the case study hospital began trialing a wireless system that would allow doctors to access the up-to-date information whilst on their rounds. The system included a wireless enabled Tablet PC, which allowed the user to just write their reports using a sensor pen, access data as well as providing the availability of a keyboard. IEEE 802.11b was used as the protocol for data transfer to allow access to the patient records. The

same graphical user interface as the ward's desktop PC appeared on the tablet. As such the interface was exactly the same as the one used to download patient information.

The development of the system included a long consultation process with the users. Training sessions were also organized however, no doctors attended. It is interesting to note that the system did not at the time of the interview, allow doctors to update the patient records and this process remained paper-based. The hospital's CIO suggested "...changes to the work process could only be achieved in small steps..." (Hospital CIO, 12/9/03) and as such functionality was purposefully limited.

Unlike the restaurant example described above, this system did not meet with a high level of success in terms of user adoption. The observed outcomes of this system include the following points:

- The system had been in use for approximately one month. At the time of implementation only one out of the three doctors on the ward had used the system. The doctor who had used the new system had only used it once and then returned to the traditional method. As such, document access was still undertaken using the old process.
- The system was perceived to be a useful tool by both the developers and users (even though they weren't using it).
- A key issue was security of the equipment. "Unless nailed down any piece of equipment will walk out of here (be stolen)." (Doctor 3, 12/9/03) This point significantly contributed to the poor success / adoption of the system, as neither nurses or doctors felt prepared to take responsibility for it if it was stolen during their round.
- The users / doctors were familiar with the technology, having to interface with a computer to download patient information.
- Access to the laptop was restricted to the doctors. The doctors believed that "if everyone else (administration, nurses etc) had access to the laptop then the system wouldn't be available for our use (by the doctors)." (Doctor 2, 12/9/03/03)
- Having tried the new system (once), one doctor returned to the old system because he felt "more comfortable with it" (Doctor 3, 12/9/03)

Although the system had been created in consultation with its users, the doctors continued to use the paper based system. It should be stressed however that this application was in an ongoing trial period and as such the potential existed for many of these issues to be addressed so that a more thorough evaluation of the system's benefits may be undertaken in the future.

5. A BRIEF OVERVIEW OF AUTOPOIESIS

Autopoietic theory is a biological systems theory developed by Maturana and Varela (1980) to provide explanations of the characteristics of living systems, as opposed to non-living systems. The processes and rules that underpin an autopoietic system's operation, provide the basis for explanations of the nature of human behaviour, cognition, the development of language and to some extent the characteristics of social system behaviour (Kay, 2001). In the context of this research project, the particular aspects of autopoietic theory that we are interested in relate to the process through which the individual relates to their environment and learns over time. The key concepts involved here are operational closure, structural coupling and structural drift and the development of consensual domains. Due to space limitations it is not possible to describe these concepts in any detail and readers are referred to Maturana and Varela (1980;1992) for a comprehensive discussion of the theory.

As an individual experiences ongoing interactions with the environment, an individual will experience what Maturana and Varela describe as a structural drift, or a gradual change to the structure of their nervous system. When these interactions become 'recurrent', autopoietic unities (humans) can become structurally coupled. This means there is a history of recurrent interactions leading to a structural congruence between the two people. Structural coupling is not limited to intersubjective relationships only but relates to all recurrent interactions in the environment of the individual and as such relates to the way in which the individual interacts with technology.

Importantly, in the context of a collaborative system, language is an example of higher level structural coupling, or what Maturana and Varela would describe as a consensual domain. A consensual domain is "...a domain of arbitrary and contextual interlocking behaviours" (Mingers, 1995,pp78) Within a consensual domain two individuals would be able to observe the attribution of meaning to common events and undertake coordinated actions. This is manifest in organisations where particular words, metaphors or language emerge to describe a shared understanding of a situation and coordinate particular activities unique to the environment of that workplace.

Work practices represent a unique form of consensual domain in the sense that where multiple people are involved, their actions require a level of coordination in order to satisfactorily complete the task at hand. As a consequence all coordinated activities are slow to develop and require considerable investment in time as individuals co-adapt with the new consensual domain of operation.

6. INTERPRETATION OF RESULTS & CONCLUSION

The two case studies discussed above present examples of both a successfully implemented system and one that was having difficulty in being accepted. Even though both systems involved considerable consultation with users during their development, the system being applied in the hospital context was failing to demonstrate a level of acceptance that would achieve critical mass. Corresponding with this lack of critical mass was a failure to see any substantive change in the work practices of the ward. This failure would not appear to be due to inadequacies in the functionality either of the hardware or the software provided. The key distinguishing feature between the restaurant and the hospital related to the degree of change required in the work process itself. The use of PDAs in the restaurant environment did not represent a significant departure from the original information input process. The PDA had a very similar look and feel both in terms of function and size to the notepads the table staff had used before. If considered from an autopoietic perspective, there was no significant change made to the consensual domain or pattern of behaviours of the participants in the system.

Conversely, in the hospital example, doctors were required to undertake an extra activity in the form of accessing information whilst “on the job” rather than before. By having already collected the information prior to seeing the patients, the doctors had some opportunity to prepare for their meetings. By accessing this information ‘on the job’, the whole order of activities had changed with an associated impact on other processes, including the way the doctors interacted with patients for example, their thought processes in terms of how they manipulated the data, even the way in which they moved around the ward. Given the extensive training involved in becoming a medical practitioner, the patterns of doctor/patient interaction used, develop over a long period and a complex process of socially interrelating, diagnosing, monitoring and recording of information (either mentally or physically). Arguably, because more complex operations and the consensual domains associated with them take longer to develop, the behaviours associated with them are more deeply ingrained into the structure of the individual and therefore a greater level of resistance to change would be expected within a consensual domain of this type.

The obverse is also true when considering the restaurant implementation. In the restaurant the activities or work practices of the floor staff were relatively simple, requiring little training and only minimal manipulation of data in order to get the job done, as such the work practices were less ingrained and the level of resistance not as great.

These observations have a number of implications when considering the implementation of a wireless collaborative system:

- Firstly, where the work practices that are to be affected involve consensual domains of action that have taken a long time to develop, change agents should expect a higher level of resistance to the implementation.
- Secondly, where higher resistance is expected, then it is likely that a greater number of changes to the work environment will be required in order to overcome the resistance. These may include changes to things like the reward system, the regulatory environment or the organisational structure. These additional changes would require the reconstruction of a variety of consensual domains, but would also be associated with considerable stress and uncertainty as the new patterns of interaction settle.
- Thirdly, as much as possible the process by which users both access and update information needs to closely mimic their existing work practice, in terms of physical activity and cognitive process if, given the time and economic constraints of many work places, the technology is to be rapidly adopted and successfully implemented.

Future research will aim to explore these observations in more detail, in order to gain a better understanding of the factors underpinning the successful adoption of wireless collaborative technologies.

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