

Business Process Affordances through the Lens of Activity Theory

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Abstract

Business process designers are increasingly being challenged to develop processes that are not only useful in achieving business objectives but also accepted by the process participants and followed in the work place. Those objectives can only be achieved when both the business and the social/cultural aspects of the specific business environment are taken into account. Humans are not unaided individuals separated from a social group and from supporting artefacts but they are complemented by the environment in which they live in. This paper presents a novel framework for the design of business processes based on the application of activity system, providing a comprehensive framework of humans acting in the world, and the theory of affordances, representing action opportunities offered by the environment. The contribution of this paper is two-fold. First, it provides a theoretical contribution to affordance studies by offering a conceptual model that consolidates new developments in the concept, post Gibson. Second, it introduces a new framework (Activity/Affordance Framework - AAF) to aid the design of business processes. Finally, a case study is used to illustrate the utility of the framework in design practice.

Keywords

Business Process, Affordance, Activity Theory, ERP Systems, AAF

INTRODUCTION

A business process is “a structured, measured set of activities designed to produce a specified output for a particular customer or market” (Davenport 1993). As business processes often require the involvement of multiple business functions and cut across organisational divisions, they are aligned to enterprise goals rather than the objectives of a specific business unit. For this reason, business process design is considered a critical success factor in many business and IT projects (Štemberger et al. 2009) and business process management is widely seen as the top priority in organizations intending to survive the current competitive markets (Gartner 2005). Business process design (and redesign) is often addressed when Enterprise Resource Planning (ERP) systems are implemented. Such systems support multiple business functions and integrate all business’s processes, including manufacturing, purchasing, warehousing, sales, marketing, human resources, finance, accounting and administration.

In spite of the benefits associated with the introduction of a formal business process design and its support via ERP, empirical evidence suggests a mismatch between process design theory and practice (Mendling et al. 2010), a lack of connection between process design and process execution (Bandara et al. 2007), and even a lack of agreement on the basic terminology of business process (Schnabel et al. 2011). Moreover, managers, relying on computer-based ERP systems, can find themselves in the position where the design of the business process, as embodied in the system, constrains their ability to make effective and efficient choices. They are often forced to make decisions without adequate information or adopt inefficient workarounds to counter previously introduced sub-optimal solutions (Sia et al. 2002). This apparent discrepancy between business process design and the eventual functional and cognitive utility of business processes as enacted within organisations clearly demands further research. The pertinent research question leading the study is therefore: ***How can affordance-driven business process design enhance the actions of the process participants?*** To answer this question a new conceptual model for the design of business processes has been adopted. Based on Activity Theory and the Theory of Affordances, which together provide a comprehensive framework for understanding human activity in the environment, the model explains the action opportunities offered by that environment to particular individuals.

The paper begins by presenting an overview of business processes and their importance in the current business world. This is followed by a discussion of affordances (Gibson 1979) and extensions to the standard affordance theory to include cognitive, cultural and social aspects of human action. This section culminates in the presentation of a conceptual model that consolidates these extensions. An overview of Activity Theory (Engstrom 2000) is further provided and its application to describing a business process based on the human activity system and different types of affordances is then given. Finally, a case study is used to illustrate the

utility of the proposed affordance/activity framework (AAF) in understanding change in a business process and its impact on people and organisational effectiveness. The paper concludes by highlighting contributions and benefits of using the proposed framework during the business process design.

BUSINESS PROCESSES THROUGH THE LENS OF ACTIVITY THEORY

Traditionally, business process design aimed at improving management and labour efficiency by structuring and specialising businesses into distinct functional areas (such as divisions, departments or centres) and increasing organisational productivity by breaking large jobs into smaller tasks that could be streamlined and performed repetitively (Smith 1999; Taylor 2005). While such models were suitable in a stable environment of the past, they gradually became out-dated in the increasingly global world of our times. Customers demanded more variety, better quality and prompt delivery of products and services, which could only be achieved with highly efficient, effective and customer sensitive operations (Hammer and Champy 1993). Since the 1990s, corporations started to look into reengineering the way they worked. Rather than maximising the performance of an individual or a function, the focus shifted to designing business processes which cut through functional boundaries and aim at achieving operational business goals.

The primary focus of the business process design is to identify people, resources and activities that need to be involved in achieving a specific business objective (Scherr 1993). During the design, many different aspects that have the potential to influence the process should be taken into account. These may include the physical environment where the process takes place, such as the layout of the work space. Physical artefacts used or created by the process also need to be considered, e.g. plant, equipment or information systems, as well as, abstract instruments, such as manufacturing formulas required to efficiently perform the work. Finally, it is important to identify roles and responsibilities of teams and individuals participating in the designed process. As business process drives all such elements, it ultimately shapes action possibilities for its participants. By focusing on enabling conditions and opportunities to act within a business process, as explained by the Theory of Affordances (Gibson 1979), it is possible to elucidate the relationship between individuals' needs and capabilities, and the structure and dynamics of the business process, thus improving the overall process design. To incorporate all action opportunities in the design it is necessary to look into how humans act in the world and what drives them to do the things they do. This can be achieved through the lens of the Activity Theory (Engestrom 2000). A business process design framework, incorporating both Activity Theory and the Theory of Affordances, is developed and explained in the following sections.

AFFORDANCES

The theory of affordance was developed in the 1960s by psychologist James Gibson who postulated that the environment delivers information that is detected by all animals through their perceptual system which allows them to explore the world directly. Through his observations, Gibson concluded that animals perceive possibilities for actions afforded by the objects in the environment. He named those opportunities *affordances* - "[t]he affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson 1979, p.127). In the human world, air affords breathing, balls afford throwing, surfaces knee-high above the ground afford sitting, and a button on a screen affords clicking. Gibson's affordances are all action possibilities in the environment, regardless of the individual's ability to recognise them. Importantly, they are at the same time related to the animal and therefore dependent on their capabilities. For example, a stairway can afford climbing for an adult but not for an infant. Over the next 40 years, Gibson's concept of affordances was gradually enriched by researchers looking into other dimensions of human actions (Barentsen and Trettvik 2002; Piccolo and Baranauskas 2010; Zhang 2007). Although researchers focus on different aspects of the affordance concept and use varying terminology, a review of work related to human-computer interaction, in particular, indicates a clear and gradual trend to expand the notion of affordances with cognitive and social aspects of human activity including experience, knowledge and culture.

To make sense of these expanded notions of affordance, a conceptual model was developed from a thematic analysis of the literature. The model positions five major categories of affordances between the two axes labelled as 'human dimension' and 'environment dimension' in Figure 1. This is important since affordances are essentially relational, as Gibson put it: an affordance "is equally a fact of the environment and a fact of behaviour" (Gibson 1979, p. 129). The 'human dimension' is divided into individual and group since some affordances occur as a result of the relationship between properties of an individual and the environment, and some occur as a result of properties of a group and the environment. The environment dimension in the model encompasses the entirety of the world we live in. It includes both physical objects and human activities. The conceptual model differentiates between environment elements that are material (labelled physical) and those that are not (labelled abstract). Between these two axes each of the five major categories of affordances are positioned depending on their primary area of application or concern. These categories are explained next.

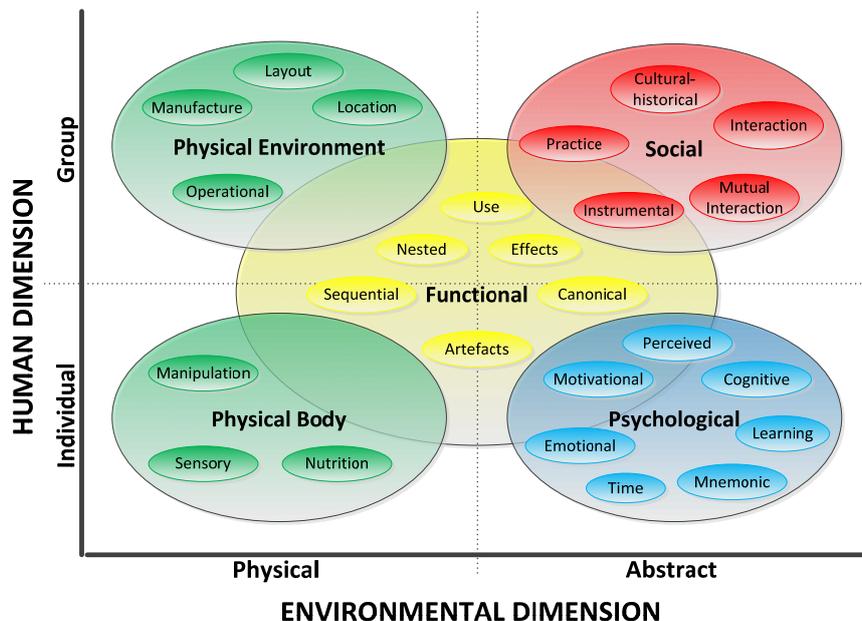


Figure 1: Two-dimensional model of affordance categories and subcategories

As shown in Figure 1, *Physical Body* affordances relate to the biological limitations of individuals. These include: manipulation affordances, related to handling an object with our body, such as grasping; nutrition affordances, related to using an object for nourishment of our body (Gibson 1979) and sensory affordances, related to our sensory actions, such as seeing, hearing, touching or tasting (Hartson 2003). *Physical Environment* affordances are derived from the constraints imposed by our environment and are more applicable for groups of people. These include: manufacturing affordances, related to developing environment substances into different objects; layout affordances, related to spatial arrangements of objects in the environment (Gibson 1979); and operational affordances, related to physical manifestation of our actions (Barentsen and Trettvik 2002). Both physical body and physical environment affordances determine what we humans are physically able to do.

Psychological affordances pertain to the abstract aspects of our actions as individuals. They are influenced by our intangible capabilities. Psychological affordances include: perceived affordances, which are related to our perceptions (Norman 1988; Piccolo and Baranauskas 2010); cognitive affordances, encompassing our cognition, for example learning (learning affordances), awareness of time (time affordances) or remembering (mnemonic affordances) (Hartson 2003); emotional affordances, related to our reaction to the important events in our lives (Zhang 2007); and motivational affordances, related to supporting our motivational needs (Barentsen and Trettvik 2002; Piccolo and Baranauskas 2010; Zhang 2007).

Social affordances relate to our lives within a social group. As we actively participate in building relationships with others and maintaining inter-personal interactions, our actions are influenced by the social structures, conventions and group dynamics. Social affordances include: cultural-historical affordances, related to adaptation of objects to suit our social needs (Barentsen and Trettvik 2002); interaction affordances, which concern social relationships around us (Pols 2012); instrumental affordances, focussing on goals shared with others (Barentsen and Trettvik 2002); and practice affordances, related to the practices used within the group (Vyas et al. 2006).

Functional affordances relate specifically to human-made artefacts designed with a specific function in mind and overlap the categories described so far as all such categories contribute to the creation of opportunities for realising a specific purpose (Gaver 1991; Hartson 2003; McGrenere and Ho 2000; Pols 2012). Functional affordances include: use affordances related to what the user can do with the artefact, for example a computer affords writing a document (Pols 2012); canonical affordances related to standard role of the human-made object, for example a canonical affordance of a printer is to print documents (Barentsen and Trettvik 2002); and artefacts affordances related to the user interpretations while interacting with the artefact, for example a specific functionality within an information system can be activated in different ways, for instance a keyboard shortcut or a mouse (Vyas et al. 2006). In the human computer interaction domain functional affordances are often sequential in time or nested in space (Gaver 1991; McGrenere and Ho 2000). Such opportunities can be revealed upon a trigger of a low-level action, which via a chain of inter-linked affordances, may lead to the execution of a high-level and functionally meaningful action. For example, the main objective of pressing a print button in a

typical software application is to print a document. While a button has a physical affordance of push-ability, it also has the functional affordance of print-ability.

Well-designed business processes and their constituent tasks can potentially offer physical, psychological, social and functional affordances to the participating individuals. Much of the design literature that draws on affordances presents a view of affordance-driven design that is fragmented and heavily biased towards the design of physical artefacts and sensory-motor interaction (Pols 2012). However, when considering the affordances of business processes, the focus needs to be placed on the relationships between an individual, the socio-organisational context of a business environment and its work activity system. Hence, to better understand the complexity of business process affordances, we turn to Activity Theory which uses the 'whole work activity' as its unit of analysis (Hasan et al. 1998) and thus provides an obvious conceptual lens to investigate business processes.

BUILDING A BUSINESS PROCESS AFFORDANCE/ACTIVITY FRAMEWORK

In this section, activity theory (AT) is developed in the context of business process design (see Figure 2), and is used to clarify and explain various aspects of affordances in business process design.

Activity Theory has its origins in 1920's Russian psychology research where Lev Semyonovich Vygotsky, Alexander Luria and Alexei Nikolaevich Leontiev developed various propositions about the nature of human activity (Nardi 1998). For instance, Vygotsky (1978) argued that all human activity is a process of social interaction within particular historical and cultural contexts and an individual's actions can only be analysed and understood within that context. Activity Theory takes a historical view of human activity, taking us back through the process of human evolution, considering personal motivations initially revolving around survival, and the emergence of intentional action. The notion of instrumentation of human activity is underpinned with the need to transmit social knowledge and influence the nature of behaviour. In other words, human interactions within the environment are not direct but mediated through the use of tools (Vygotsky 1978). Social and cultural mediation is recognised to influence what we do in the world. And thus, the history of communal life provides a backdrop for understanding community interactions, the use of laws, power and division of labour, which caused Leontiev (1978) to further differentiate between individual and collective activities, as well as, conscious and non-conscious operations (Leontiev 1978).

In Activity Theory, *Activities* are the unit of analysis and represent systems with their own internal structure and transformations. Activities connect the individual with the culturally and socially rich environment and are oriented towards human motives that are often collective. Each motive is an *object*, material or ideal, that satisfies a personal or social need. While motives do not have to be conscious, they largely relate to the personal conception of the 'self'. For example, while the organisational motivation for a payroll process is to provide their employees with pay for the work done, a payroll manager's motivation is likely to be (at least in part) to comply with their position's duty statement and thus to regularly and efficiently execute payroll runs.

In the business context, the actions undertaken by a *subject* (the individual or team involved in the business process), for example operational manager responsible for the payroll function, or an administrative staff entering the timesheet data, are targeted towards the *object* (the reasons for the process taking place), for example effective and efficient payroll processing (see Figure 2). The relationship between the subject and the object is mediated through the use of physical and conceptual *instruments*, for example tax tables, are a conceptual instrument that is used in the payroll process. The business process takes place in the *community*, where responsibilities are allocated through the *division of labour* and where *rules*, such as explicit regulations or implicit cultural norms, are in place (Engestrom 2000).

Business processes, prescribing tasks to be performed in the business, have the capability to offer action possibilities and can therefore provide affordances to the participating individuals or teams. While different categories of affordances can be interrelated, they can be seen to link up with the specific elements of an activity system as presented in Figure 2 (Adapted from Engestrom 2000, p. 962).

Environment and instruments are used by the subject to affect the object of the business process and provide **physical affordances** to the process participants, which is illustrated in the top triangle of the AAF model (see triangle A in Figure 2). Some affordances are related to our biological capabilities (physical body), for example a manufactured product weighting 15 kilograms can be carried by an employee while one weighting 50 kilograms cannot. Other affordances are derived from the constraints imposed by our physical environment, for example a building layout may encourage us to use the stairs to get to the office above, if the lift is much further away in the building.

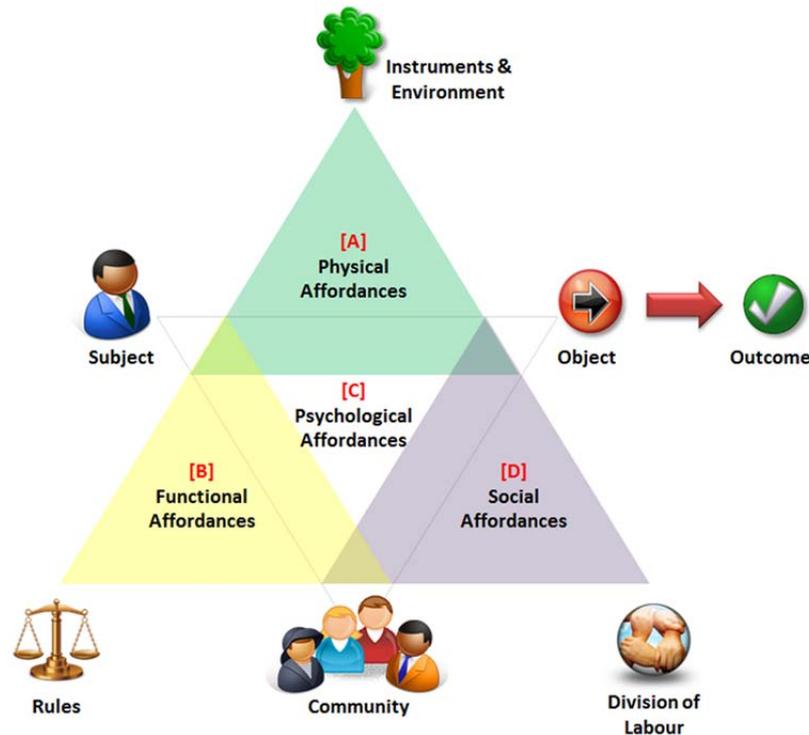


Figure 2: Affordance/Activity Framework (AAF) for business process design

The community includes process participants and customers, for example the employees who must be paid or section heads who require new employees. Division of labour, determining who in the community can or is expected to perform specific tasks in the business process, can provide **social affordances** to the subjects, which are illustrated in the lower right triangle (D) of the AAF model. Specific examples of the business environment offering social affordances to the subject include: training of subjects by more knowledgeable process participants; interaction within the business process community, such as administrative staff rechecking presented timesheets with employees, or authorisation of submitted purchase orders by managers.

Various legal, organisational and cultural rules, applied by the business community to establish what members may or may not do, have functional purpose, as subjects need to acquire them and use them in their action planning, and these can provide **functional affordances**, which are illustrated in the lower left triangle (B) of the AAF model. Specific examples of the business environment offering functional affordances include: consolidated payroll processing in a group of companies, National Employment Standards, or Income Tax Assessment Act.

Finally, **psychological affordances** emerge between an individual, object (the motive behind the business process) and community and are denoted by the middle triangle (C) of the AAF model. Specific examples of the business environment offering psychological affordances include: making administrative staff part of the payroll process team and motivating them to work towards the process objective, for example the accurate and timely payroll processing.

Environment and mediating concepts of activity system, such as instruments, rules and division of labour will all contribute to the affordances provided by the business process, as presented in Figure 2. Elements of the AAF model are highly interrelated, which reflects the complementarity of the subject and business environment. Such complexity is illustrated in Figure 2 by the overlapping areas of different affordances. For the sake of brevity, we will restrict ourselves to an example of how physical and social affordances overlap. While physical affordances are determined by the subject, object and instruments/environment, they are also contributed to by community with rules and division of labour. For example, business rules and division of labour at the site may require that the use and access to specific business equipment would only be allowed when the employee presents a licence to operate machinery (rules) and has an access key to a specific plant (division of labour). In the case of social affordances, while they are determined by the community, object and division of labour, they would also be influenced by subject, instruments and rules. For example, the business environment offering social affordances to the subject would also be shaped by information systems enabling collaboration between different parties (instruments) or the schedule of working hours (rules).

Having detailed the framework, we now use a case study to explain the redesign of a payroll business process through the lens of AAF.

CASE STUDY

The case study focuses on a corporate group of 6 companies in the Australian commercial services industry. The group introduced an ERP system over a 3 year period, and during that time, four other companies were acquired and gradually deployed the new system. In the course of this change, many different business processes were altered; some were completely automated and others were assisted with the new systems. However, for this discussion we will focus on the significantly re-engineered payroll process.

The initial process review identified significant ineffectiveness and inefficiencies in the payroll process. At one end of the process, employees in each company were entering their hours worked into timesheets, which were then submitted manually to their operational managers for authorisation and subsequent data entry and processing. Errors in data entry were quite common; consequently, corrections and adjustments had to be made regularly. This problem was further complicated by security issues in smaller companies, where sensitive payroll reports were commonly sent to the shared printers, potentially accessible by unauthorised personnel. Moreover, due to the complicated legislation, payroll procedures required employees servicing the process to have very extensive knowledge, which simply did not exist in some smaller member companies, especially those functioning in remote areas. Due to the above problems instances when payments to the employees were in error or delayed were not uncommon.

In this case study, we consider the payroll process, as a whole, to be the activity system. Each element in the activity framework first needs to be identified from particular stakeholder perspectives. This is crucial because as explained earlier affordances are essentially relational. At the highest level, the payroll department itself is a subject and we first consider each element of the AT and the corresponding affordances from this stakeholder view. Figure 3 summaries the payroll redesign from this perspective showing the relevant affordances in each triangle. This part of the redesign is explained next.

The major change in the payroll process related to its consolidation on a group level, which involved a change in rules of the payroll activity. The redesign offered new functional affordances as shown in Figure 3 (lower-left triangle). While people were still employed by different member companies, it was decided that only one payroll department would become responsible for the overall payroll processing. To take advantage of the existing expertise and experience in handling large payroll runs, the payroll department from the company employing the largest number of staff within a group took on the role of the overall payroll processing. A new member of staff was employed to assist in handling the newly generated workload, while payroll personnel in smaller companies were released to other, non-payroll related, jobs. Additional business policies were enforced within a process, and implemented in the new information system, to warn payroll officers about the occurrence of any exceptions. This could happen, for example, at the entry of timesheet data to identify timesheets with more than 8 hours of overtime or with annual leave taken that did not accrue; or at the payroll processing stage, for example when a net pay for an employee of a specific company exceeded a specified amount. The new ERP system was configured to support many other rules established within the payroll process, such as automated pay disbursements, by generating and submitting bank files from payroll data; or online dealings with the Australian Taxation Office.

Consolidation of payroll on a group level also changed how labour was divided amongst the community, and specifically timesheet and plantsheet entry. The redesign offered new social affordances as shown in Figure 3 (lower-right triangle). Each site had at least one administrative officer who provided direct services to the site employees. The staff of the payroll department, on the other hand, was located in other locations, and thus, had no direct contact with the operational side of business and rarely met employees face to face. While in the past, administrative staff collected timesheets and organised managers' authorisation without much personal interaction in the process; in the new system, they became directly responsible for timesheet data entry online and thus were able to react to the system warnings and discuss detected problems with the relevant employees on site. As problems started to be corrected closer to the point of their occurrence within a process, the positive effects were quickly noticed. Increased interaction between administrative staff and workers, made employees more aware of the need to submit quality data to avoid problems downstream in the data processing chain. This was evidenced in increased legibility of submitted timesheets and double-checked accruals before leave was claimed. The latter was facilitated by the design of a new pay slip that included detailed entitlement and pro-rata information for all leave accruals. Additionally, the payroll department became responsible for conducting the internal training for admin staff and these in turn for conducting data entry training for employees.

The improved payroll also required changes to the instruments and environment used in the business, which offered new physical affordances as shown in Figure 3 (upper triangle). The payroll office had to be moved to

new office space and the furniture layout was adjusted to ensure that the staff could face people entering the room. A new laser printer dedicated to only payroll was placed at the back of the new office space. The new ERP system was deployed to facilitate the performance of some process tasks, for example pay disbursement.

Process changes offered new psychological affordances to the participants as presented in Figure 3 (middle triangle). Payroll employees responsible for the new process were sent to the comprehensive payroll training to ensure that their expertise level matched their increased responsibilities. System entry screens were simplified and links to infrequently used functionality hidden to improve the perception and recognition of possible actions. The design of payroll forms, such as timesheets and plantsheets, was unified throughout the group and the forms were simplified by deleting unnecessary information. Before the change, in some companies, tractor feed printers were used with A3 size paper, which made report reading a challenge. The overwhelming quantity of information available on such reports was often not needed and users would turn to a ruler to follow the details of a specific record. The new system generated all payroll reports in the A4 format, which was easier to read and comprehend.

All previously described changes in the process design offered new and direct affordances to two types of subjects, i.e. administrative and payroll staff. These subject-specific affordances are discussed next.

For administrative staff physical affordances of new stationery and information system offered easier timesheet entry and simpler reporting. Functional and instrumental affordances provided by online timesheet entry and exception warnings facilitated more accurate work. Social affordances of internal training and mutual interactions made administrative staff feel part of the payroll process team and improved collaborations between the process participants and customers which lead to more effective work. Perceived, cognitive and mnemonic affordances offered by standardised forms, simplified menus, and A4 reports facilitated more efficient timesheet entry. It is worth noting that some changes in the process design can offer affordances from multiple categories, for example exception warnings provide a new functionality aimed at achieving more accurate pay processing but at the same time they also provide psychological affordances by making perception of a specific exception much easier. All new affordances for administrative staff contributed to the fulfilment of payroll process goals such as improving skilled labour and accurate and timely timesheet entry which is presented in Figure 3.

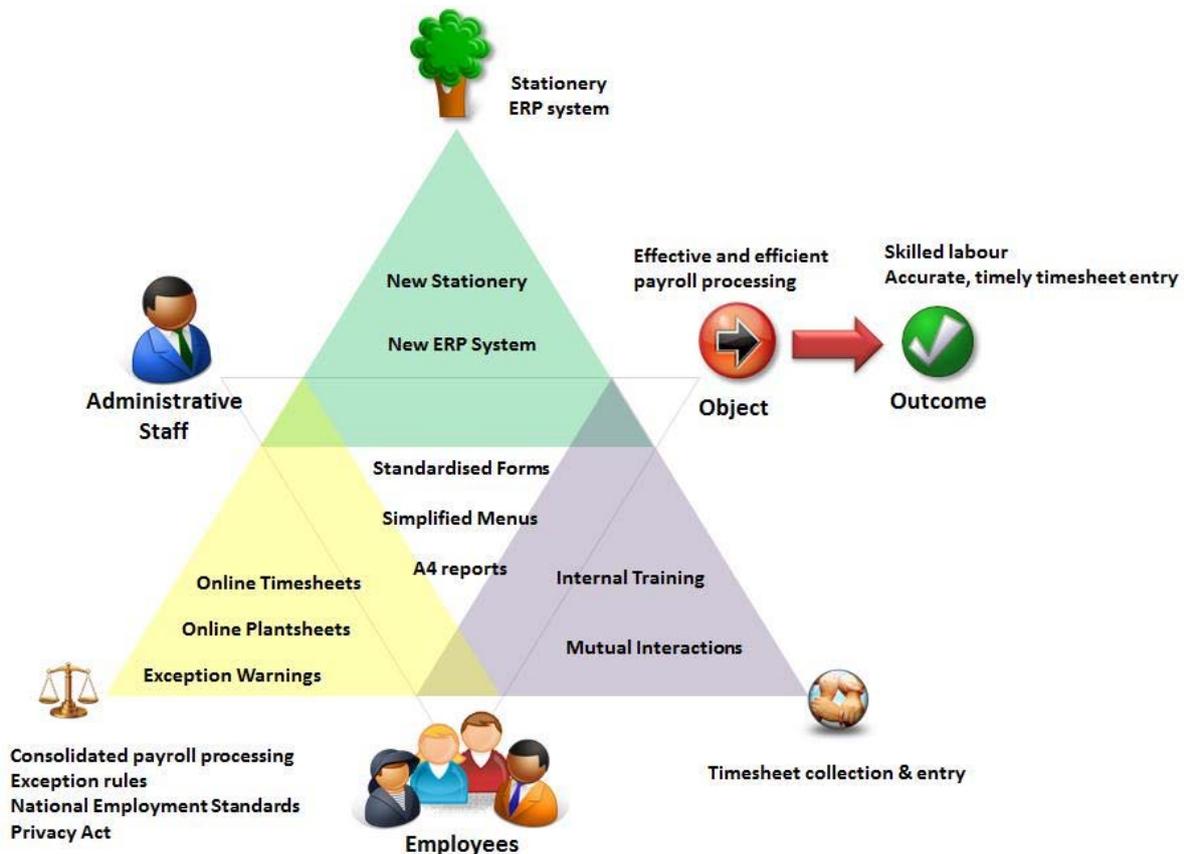


Figure 3: Changes in the design of payroll business process for administrative staff

For payroll staff, the physical affordances of a new office, furniture layout, dedicated payroll equipment and new information system facilitated secure pay processing. Functional and instrumental affordances offered through

exception warnings, pay automation and payment summaries generation facilitated more accurate and timely pay processing. Social affordances of internal training and mutual interactions improved cooperation between the process participants which lead to more effective work. Perceived, cognitive, mnemonic and motivational affordances provided by advanced training, simplified menus, standardised forms and A4 reports facilitated faster and more effective payroll processing. All new affordances for payroll staff contributed to the fulfilment of payroll process goals such as improving skilled labour and accurate, timely and secure pay calculation, payment, pay slips, super, leave and end of the year processing, which is presented in Figure 4.

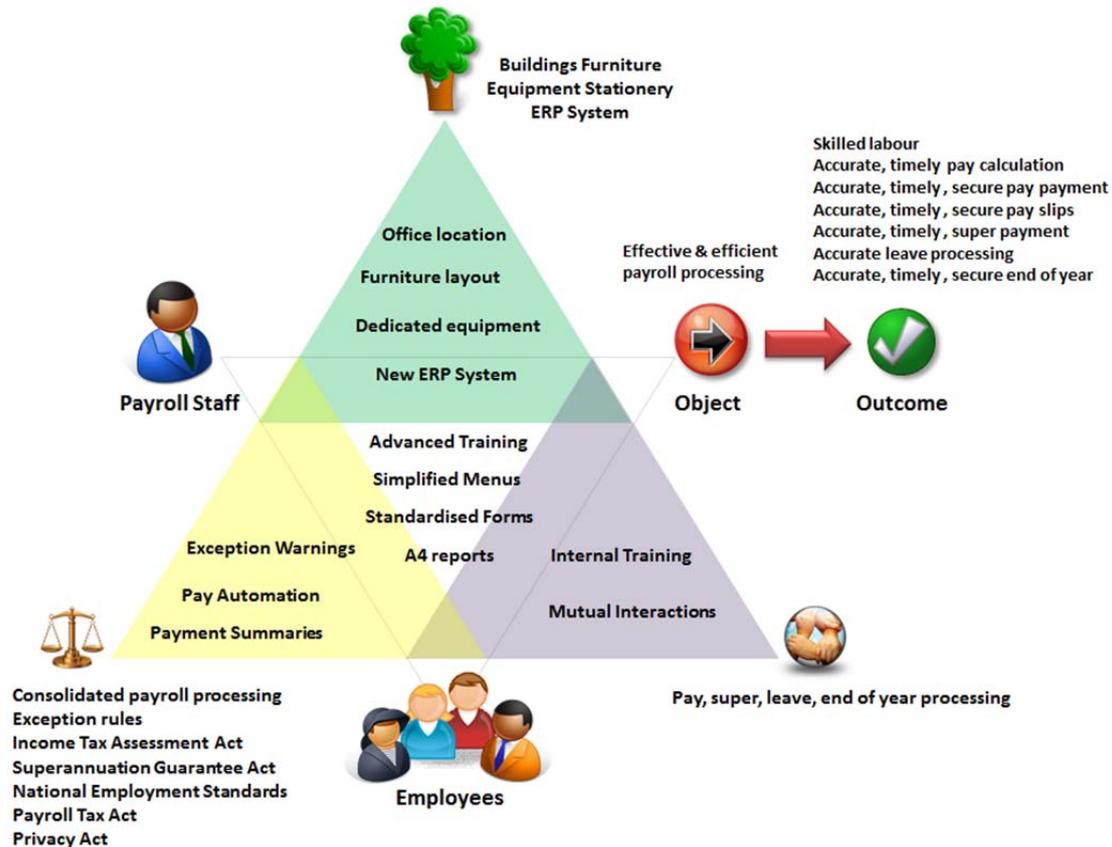


Figure 4: Changes in the design of payroll business process for payroll staff

The new payroll process afforded more secure settings together with a more effective and more efficient work environment to different process participants, which in turn advanced the process objective. Within the first few months, the number of instances when employees complained to the payroll department about their pays being incorrect significantly diminished. The time required for timesheet entry decreased and there were no more instances of pays being delayed. The feedback from process customers (employees) confirmed that they are more confident about the security and accuracy of their pays after the change.

CONCLUSION AND FURTHER RESEARCH

Many extensions to the theory of affordances have been proposed since Gibson introduced the concept in the 1960's. This paper undertook a thematic analysis of the literature post-Gibson to provide a conceptual model demonstrating how each type of affordance relates to different human and environmental dimensions (see Figure 1). This model may assist researchers and designers in selecting affordances that are most appropriate for particular areas of design concern.

Affordances provide action opportunities, and business processes prescribe tasks to be performed in the business activity system and therefore have the capability to offer action possibilities to the participating individuals or teams. For this reason, we joined the affordance model with activity theory to provide the Activity/Affordance Framework (AAF) to assist in business process design. The model is not intended to replace existing BPD methodologies or to take into account the rich tapestry of social, organisational or personal factors in the design of business processes. However, the model can be used as a sensitising lens to ensure that all necessary affordances are considered during the design process.

We applied the framework in a post-hoc study of a payroll process redesign. The exercise demonstrated that the notion of affordances can be usefully applied in the context of business process design; however, further research is needed to test the framework in guiding a new business process design project.

The design of business processes influences human motivation, goals and the business environment by affecting both tangible and intangible aspects of that environment as they relate to specific individuals or groups. To reap the benefits of a good process design, we need to ensure that all aspects of human behaviour, such as operations, actions and activities, are taken into account and all types of affordances, such as physical, functional, psychological and social, are duly considered. Process designers should consider the social and organisational context in which the processes take place to avoid poor matches with the participants' needs, misalignment with business policies and plans, confusions of roles and responsibilities in practice (Dobson et al. 2004), and as a consequence, often poor levels of process acceptance not only by the participants but also customers. Focusing on action opportunities has a great potential to improve a process design by enriching it with individuals' needs and capabilities and ultimately creating the connection between process design and business performance.

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