Bringing Together Evaluation and Management of ICT Value: A Systems Theory Approach

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Abstract: The paper introduces an evaluation model for examining an Information Communication Technology (ICT) value creation process based on a systems theory method, known as cross-impact analysis. This method enables holistic understanding of interdependencies among the system's elements, critical for successfully evaluating and managing the system. The evaluation process focuses on six dimensions of an ICT value creation system: drivers, outcomes, identity, goals, trends and its structure. Each of these dimensions has important implications for managing the system. Thus, the evaluation model presented in this paper integrates the evaluation and management of a system, with the purpose of enabling organisational stakeholders to use the evaluation as the basis for informed management of their ICT value creation system.

Keywords: Systems theory, ICT evaluation, ICT management, ICT value creation system, cross-impact analysis, interactions

1. Introduction

The purpose of evaluating Information Communication Technology (ICT) is to gain an understanding of how ICT is contributing to organisational performance in a given organisational context. Ongoing ICT evaluation is particularly relevant in the post-implementation period where it should be used to improve the ICT value creation process, that is, to bridge the gap between intended and realised ICT value (Davern and Kauffman, 2000). Evaluation information can also be used for subsequently modifying management actions in order to improve ICT value through resource control and allocation, ICT use and an organisation's business processes (Song and Letch, 2012).

Organisations which use post-implementation evaluation techniques have higher perceived payoffs from ICT (Tallon, Kraemer and Gurbaxani, 2000). However, most companies are unlikely to revisit their initial ex-ante Information System (IS) evaluations and to determine whether or not the IS investment is actually performing according to plan (Tallon *et al*., 2000). Instead, evaluation is being used to gain IS project approval on one hand, and to formally complete the project on the other (Nijland and Willcocks, 2008). This may constrain the realisation of ICT value in the post-implementation stages of ICT diffusion.

This paper proposes and demonstrates the application of the systems theory method, cross-impact analysis, in a medium sized organisation to illustrate the importance of bringing together evaluation and management of an ICT value creation system. Cross-impact analysis considers the ICT value creation process as a system composed of technological, individual, organisational and environmental groups of factors, thus, limiting blind spots in evaluating and managing ICT value (Asan, Bozdag and Polat, 2004). It is a case based method as it captures tacit knowledge of organisational stakeholders on interactions between ICT and other organisational resources. Further analysis of these interactions identifies the functional position of each factor in the ICT value creation system, which has important implications for managing ICT value (Cole, Allen, Kilvington, Fenemor and Bowden, 2007).

The approach taken in this paper provides insights into the complex process of ICT value creation and a range of options for using the evaluation information for improving it. This is in contrast to traditional IS evaluation that uses traditional finance and economic based techniques (Song and Letch, 2012) that reflect a conceptualisation of technology as yet another form of capital. This leads to technological determinism and consideration of ICT in isolation from other parts of the organisational system. That is, ICT impact on the organisation can not only be misunderstood, but can also be ineffective. Thus, in order to evaluate its impact on a company's performance ICT needs to be recognised as a social system which is designed, used and influenced by people (Orlikowski and Iacono, 2001; Checkland and Holwell, 1998).

Systems theory is discussed next as a theoretical framework underpinning this study. In the methodology section, Organisation B's context and the cross-impact analysis are discussed. Next, the findings are presented and discussed in terms of their usability in managing ICT value. Lastly, the implications of the findings are outlined in the conclusion section.

2. Systems theory and its view on evaluation of ICT value

Ludwig von Bertalanffy established systems theory as a theoretical science directed at researching systems and the characteristics they have in common as general aspects of reality (von Bertalanffy, 1972). Due to its interdisciplinary perspective, and its foundational principles of physics, biology and engineering, systems theory has been used in numerous fields, including management, psychotherapy and economics (Skyttner, 1996).
Von Bertalanffy (1972: 17) defined a system as being a "set of dynamic elements maintaining integrity via mutual interactions". A system is defined as being a set of two or more interrelated elements that satisfy the following conditions (Ackoff, 1971):

- The behaviour of each element has an effect on the behaviour of the whole;
- The behaviour of the elements, and their effects on the whole, are interdependent, as determined by the state or type of activity in at least one other part of the system;
- All subsystems have an effect on the behaviour of the system, but none has a solely independent effect on it.

In order to evaluate ICT value in an organisation, the dynamic process of ICT value creation needs to be further understood. The factors which influence process of ICT value creation need to be identified, and the influencing mechanisms need to be analysed. In order to do this, the process of ICT value is conceptualised as a system and is further analysed using a systems theory research method, cross-impact analysis. Systems theory posits that a system is created and determined by interactions among the system's elements. It has been recognised that ICT value emerges as a result of complex interactions between ICT and other organisational resources (Nevo and Wade, 2010). The principles that guide the conceptualisation of ICT value creation system are further explored in the following section.

2.1 ICT value creation system

ICT value creation system is an artificial system, that is, it is designed by humans to have certain characteristics in order that organisational goals can be achieved. Consequently, the following aspects of an artificial system should be considered when evaluating it (Simon, 1990):

- The purpose or goal of the artificial system
- The structure of the artificial system
- The environment in which the artificial system performs.

The first aspect of an ICT value creation system is its purpose which is determined by organisational goals which determine different functions and use of ICT. The purpose of ICT can be further classified as desired ICT effects, which have been categorised as informational, strategic, transactional and transformational (Gregor, Fernandez, Holtham, Martin, Stern, Vitale and Pratt, 2004). Informational ICT effects ensure faster and easier access to reliable, accurate internal and external information, transparency of business processes, as well as identification of bottlenecks in the production process. Strategic ICT effects shape organisational ability to create competitive advantage, align business strategies to directly support organisational goals, and improve relationships with customers. Transactional ICT effects ensure operational and cost savings, supply chain management savings, staff cost savings, and improved business efficiency of both employees and business processes, and financial resources. Transformational ICT effects are associated with improved skill levels, new business plans and business models, expanded capabilities, improved structure and processes, as well as creating a culture conducive to change and innovation. If ICT does not support the organisational goals, it can inhibit an organisation's development, and become a legacy system.

Weill and Olson (1989) explain that organisations experience different ICT effects because some are more successful in converting ICT investments into useful output. This process is known as conversion effectiveness, and it is influenced by internal ICT management processes in organisations. Organisations differ in terms of ICT

infrastructure, number of activities and levels of management that are supported by ICT. Simply investing in ICT does not result in ICT value. The essential mechanism for ICT value creation is interaction and synergy between ICT resources and complementary organisational resources (Melville, Kraemer and Gurbaxani, 2004; Wade & Hulland, 2004). Kohli and Grover (2008) recognise that ICT creates value only under certain conditions, that is, when ICT synergistically operates with other organisational factors.

In their model, Soh and Markus (1995) explain the process of ICT value creation. ICT investment may lead to development of ICT assets, that is, ICT infrastructure defined as ICT expertise and ICT applications. Not all organisations develop ICT infrastructure. Of critical importance in development of ICT assets is IT management, as well as high level of users' ICT knowledge and skill, well-designed applications and flexible ICT infrastructure. Next, ICT assets will lead to ICT impacts when ICT is used appropriately by users, and in line with organisational directives. ICT use will depend on organisational structures, processes and culture. Lastly, ICT impacts will lead to improved organisational performance, depending on structural factors, that is, size of the organisation and industry competitiveness, customer and competitors' reactions.

The second aspect of an ICT value creation system is its structure that encompasses technological, as well as organisational context. The performance of the system depends on the effectiveness of both the organisation and employees (Simon, 1990). Moreover, an ICT value creation system is bound up with the historical and cultural aspects of its ongoing development and use in an organisation (Orlikowski and Iacono, 2001). When considered in this context, ICT value is the result of ongoing social, managerial and economic practices within an organisation.

The third aspect of an ICT value creation system is the organisational environment in which it operates. An organisational environment is defined by both internal and external contexts. It is affected by the degree to which ICT system is aligned with other organisational contexts and the degree to which the system supports realisation of organisational goals. The environment external to the organisation, such as available technologies, market trends, and behaviour of other economic actors and/or markets (Simon, 1990), determines the conditions for ICT goal attainment.

In summary, an ICT value creation system serves the goals of the organisation it is embedded in, and its structure reflects a holistic consideration of technology, users and organisation that perform in a specific environmental context. ICT value creation system can further be defined as a set of dynamic elements, belonging to technological, individual, organisational and external environmental contexts (Melville et al., 2004), that are linked through mutual interactions. Systems theory defines the principles used for evaluating such a system.

2.2 Evaluation of a system

Systems theory posits that the performance of a system depends on how well that system's elements interact and fit together, and also how that system functions in relation to the larger system that conditions it. In other words, the performance of a system is not the sum of the independent effects of its parts. Instead, it is the product of their interactions (Ackoff and Gharajedaghi, 1996). Therefore, effective evaluation and management of a system requires managing the interactions of its parts, rather than attempting to manage and control the separate parts (Ackoff and Gharajedaghi, 1996).

A systems theory approach is concerned with total-system performance and treats a system as a whole entity, not on its parts taken separately. By reducing a system to its individual parts, both the system and the parts lose their properties (Ackoff, 1971). Thus, the performance of any part of a system needs to be properly assessed including its interaction with the whole system, otherwise, the overall system's performance will be reduced.
System theory suggests that the evaluation of a system takes into account the following:

- **The system as a whole.** All parts of a system should be recognised, instead of focusing on its parts as separate entities. This implies that IS evaluation needs to consider IS not as a separate entity, but as a part of an organisational system where IS interacts with the organisational context, both internal and external, and users. Thus, evaluating only a part of a system may give misleading information and any subsequent management action may reduce the system's overall efficiency and efficacy. In addition, a

system and its properties change over time, but the system maintains its identity by converging its parts into a whole (Tona and Carlsson, 2013).

- **Interactions and interdependencies among a system's elements.** Interdependencies among system's elements determine if a change in one part of a system will have no influence, a small or a drastic influence on other elements in the system and the system itself (Tona and Carlsson, 2013). Without taking into account interactions among a system's elements, a change in a part of a system can lead to unexpected consequences in other parts of the system and can lead to overall, unintended results. Evaluation that considers interactions and interdependencies can provide understanding on how a system develops, evolves, and realigns itself when responding to changes in the external environment. It can also provide valuable information for management on how to bridge discrepancies between a system's actual state and its desired state. Thus, evaluating interdependences is critical for evaluating and managing the system.

- **Emergence of a system and its properties which are created by context-dependent and non-linear interactions among the system's elements**. Emergence refers to the system itself that exhibits behaviour and characteristics that are not possessed by its parts and cannot be reduced to those of its parts (Tona and Carlsson, 2013). A system can be studied through its elements and their interactions and interdependencies. Furthermore, a system's structure, that is, a specific combination of system's elements, determines the joint effect that elements have on the system's behaviour (Tona and Carlsson, 2013). Thus, evaluation of a system should consider emergence by focusing on the structure of system's elements.

Systems theory provides an alternative understanding of the evaluation process by considering the dynamic interactions of the system's elements (Patton, 1990). A specific systems theory method, cross-impact analysis, focuses on evaluating a system by capturing and analysing interactions among its elements. As such, it demonstrates the integration of evaluation and management of a system. Cross-impact analysis is further discussed in the following section, and its application in evaluating an ICT value creation system in a medium-sized service organisation is presented.

3. Methodology

This paper focuses on application of the cross-impact analysis method to a single organisation in order to illustrate its value in bringing together the evaluation and management of an ICT value creation system. Application of the cross-impact analysis encompasses three steps. These are a) identification of the system that produces the results; b) assessment of the interactions between the system's elements; and c) visualisation of the system and classification of its elements based on the functional position of each element in the system. Information from each step of data collection is used as an input for the next step of the research design. For example, semi-structured interviews were analysed using thematic analysis with a purpose to identify the elements of the ICT value creation system. Interactions among them the identified system's elements are then assessed by organisational experts. Assessed interactions were further analysed and used to evaluate the system and provide insights into using the evaluation information to manage the system.

Cross-impact analysis focuses on understanding the complexity of a single case (Yin, 2003), and as a result "to appreciate the uniqueness and complexity of its embeddedness and interaction with its contexts" (Stake, 1995: 16). Focusing on a single case enables a detailed contextual analysis of an ICT value creation system and its relationships with the organisational context (Dooley, 2002). Hence, the value of the cross-impact analysis is in its in-depth, holistic visualisation and understanding of a complex system through analysing interactions among its elements that enables the system's evaluation and management.

3.1 Research setting: Organisation B

Organisation B participated in the research project. The organisation has over 300 employees. Its regional focus since 1940s, when it was established, resulted in a monopoly position in the Croatian regional market. The perception in the company is that competition has no effect on its operations. In order to complement and support the main business activity, it developed two additional business activities, sales and marketing, to complement production, and accounting and finance. ICT applications have been developed separately in each

of the three departments. The production department uses an old version of the information system that links its operations with a partner organisation which has a critical role in the production process. The marketing department, located in another part of the town, depends on timely and accurate communication with the production department on daily basis. Communication between these two departments is restricted due to old technology. This creates issues with ensuring customer satisfaction. The sales department outsourced IT support from an external provider and implemented the latest IS. As the latest versions of IS do not support the old version of the IS in the production department, the two systems are neither compatible nor integrated with one another. Next, the accounting and finance department has obsolete IS that is not compatible or integrated with any other IS. Sale outlets do not have point of sale software, and inventory is done manually. This creates a significant cost for the organisation and a delay of up to a month in distributing important management and financial reports. The organisation has found itself in a complicated situation where evaluation of its ICT value creation system seems as a good place to start. Understanding the interactions and the role of specific factors in the system can inform the management of how to approach further developments of IS in the organisation.

Moreover, the key performance indicators are not defined and the overall goal is completing the required business activities on daily basis instead of dealing with the integration and compatibility between each department. Additionally, management failed to invest in updating and integrating technology, as it did not recognise the strategic importance of ICT. Thus, the company's adaptation to market requirements has suffered. The IT department is presented with the challenge of integrating ICT applications at the organisational level. Given this situation, the investigation sought to evaluate the ICT value creation system in the organisation by applying cross-impact analysis so as to provide valuable insights into managing the system.

3.2 Cross-impact analysis

Cross-impact analysis is a systems theory research method that is specifically used to explain and evaluate a system based on analysis of the interactions among its elements (Messerli, 2000; Schlange, 1995). It is based on a cross-impact matrix (also known as an influence matrix, a sensitivity model and a networked thinking method), defined as "a mathematical network model that can be used to numerically portray complex systems" (Cole et al., 2007: 383). The method emphasises the whole system instead of individual components; and focuses on the purpose for which the system was created, together with the interactions and interdependences among the components of the system.

Cross-impact analysis was developed by Helmer (1972) and Gordon and Hayward (1968) as a forecasting technique that is an alternative to the Delphi method. Several modifications have been made to the original method as described by Cole et al. (2007), although all versions of the method produce a ranking of factors, that is, system's elements, by mathematically evaluating the cross-impact matrix.

Godet (1979) developed the MICMAC method by introducing an algorithm that captures not only direct, but also indirect impacts among system's elements. This algorithm is not applicable to every system as explained by Fried and Volker (2005). Vester and Hesler (1982) developed a simplified scoring strategy that quantified the impact of one factor on another on a scale 0, 1, 2 and 3 (no impact, weak impact, medium impact and strong impact). This required a change in the solution algorithm, so Vester and Hesler combined active and passive sums to classify factors. By doing so, they developed a functional factor typology that categorises system's elements based on the influence each element exerts on other elements, and the influence each element receives from other elements (Cole at al., 2007). The proposed typology was further developed to include continuous classification (see Vester 2004; Messerli, 2000; Schlange, 1995) which is applied to the analysis of ICT value creation system in this study.

3.2.1 Step 1: Conceptualising a system: Identification of a system's elements

The first step of the cross-impact analysis is to identify a set of factors that describe a system (Asan et al., 2004). This is a critical step as it provides the basis for the other two steps in the cross-impact analysis. Semi-structured interviews with 18 stakeholders in Organisation B [employees (7), IT employees (3), IT managers (2) and senior and top managers (6)] were used to identify factors that describe the ICT value creation system in the Organisation. Contacting respondents from different departments who offer different viewpoints on the phenomenon being studied is a common strategy for increasing the validity of a case study (Eisenhardt and Graebner, 2007). Stakeholders who participated in the interviews were identified using a snowballing

strategy (Miles and Huberman, 1994). That is, interviewees themselves suggested other potential interviewees. Interview questions were developed based on the review of the ICT value literature, and focused on the technological, individual, organisational, and external environmental contexts and the four categories of ICT effects.

Interviews were recorded and transcribed which enabled further analysis of the interviews using thematic or content analysis (Saldana, 2009; Braun and Clarke, 2006). This resulted in identification of factors that describe the ICT value creation system in Organisation B. The reliability and validity of the findings was established by triangulating them with the factors identified in the literature as influencing ICT value, as suggested by Khoumbati, Themistocleous and Irani (2006). This approach ensured that the elements of the ICT value creation system in Organisation B confirm and reflect previously published research on ICT value. They are further outlined in Appendix 1.

3.2.2 Step 2: Evaluation of interactions among the system's elements

After identifying the system and its elements, all interactions among the elements are systematically assessed in the second step of the cross-impact analysis. Relationships are assessed by experts, that is, organisational stakeholders who are knowledgeable in the process being investigated in terms of a) direction and b) strength of each relationship (Cole et al., 2007). The direction of a relationship between two factors indicates whether an increase or decrease in factor "X" results in increase or decrease in factor "Y" (Kardaras and Karakostas, 1999). The strength of a relationship is the degree to which one factor influences the other (Asan et al., 2004). The scale used for measuring the strength of each relationship reflects the linguistic fuzzy approach: strong influence, medium influence, weak influence or no influence. Using a fuzzy linguistic scale allows experts to express their beliefs on the strength of a relationship. This is a preferred option as assigning numerical values to each relationship is tiring for the experts (Jeong and Kim, 1997).

For the purposes of this study, two IT managers were identified as experts due to their knowledge, understanding and experience with ICT as well as organisational context in Organisation B. They assessed each relationship among the previously identified set of factors in an additional interview. The presence of the researchers ensured that in those instances where the two experts disagreed on the strength of the relationships, they would justify their view and reach an agreement. Fuzzy linguistic scale was translated into a numerical continuous scale: 2, 1, 0.5 and 0 (strong, medium, weak and no influence) as presented in Appendix 2. In order to ensure the clarity of interactions and system dynamics those interactions with positive direction are presented in a positive cross-impact matrix, and interactions with a negative direction in a negative cross-impact matrix.

3.2.3 Step three: Visual representation of the system

In the third step of the cross-impact analysis, information gained from the IT experts on the strength of each relationship between the system's elements was used to calculate the four indicators for each factor in the cross-impact matrix, as shown in Table 1. Further information on the value of indicators for each factor is available in the Appendix 2.

Table 1: Cross-impact indicators

Indicator	Explanation	Interpretation
Active sum (AS)	Sum of all values in each row of the matrix	The total effect a cause factor (X) has on all effect variables ($Y_{\Sigma i}$)
Passive sum (PS)	Sum of all values in each column of the matrix	The total effect an effect variable (Y) receives from all cause variables ($X_{\Sigma i}$)
Degree of activity (AS/PS)	Dividing AS by PS values for each factor	The overall influence the factor exerts on other factors in relation to the influence it receives from all other factors
Degree of interrelation (AS*PS)	Multiplying AS and PS values for each factor	Integration of the factor with the system

Degree of interrelation and *degree of activity* are critical indicators used for further evaluation of the system and for creating a visual representation of the system. They integrate Active Sum (AS) and Passive Sum (PS), and thus, explain each factor's individual role in relation to the overall system. Both indicators are further used

to develop a map of interactions, which visually displays the whole system and shows the position of each of its elements. More specifically, degree of activity is used as an *x*-coordinate, and degree of interrelation as a *y*-coordinate for positioning each factor in the map of interactions (Skoko, Buerki and Ceric, 2006).

Each factor is depicted by two points on the map connected by a line, one point based on degree of activity and degree of interrelation from a positive cross-impact matrix (a circle) and the other point is based on the same coordinates from the negative matrix (a triangle). For example, the circle's coordinates of Factor 1, ICT integration, are determined by its degree of activity (0.83), and degree of interrelation (330) as indicated in the positive cross-impact matrix (Table A2.1). The triangle's coordinates indicate its degree of activity (6) and degree of interrelation (6) in the negative cross-impact matrix (Table A2.2).

The key to interpreting the position of each factor in the map of interactions is its degree of interrelation and degree of activity. Based on these indicators, each factor can be classified as a driver, outcome, identity, goal or trend of the system, as indicated in Figure 1.

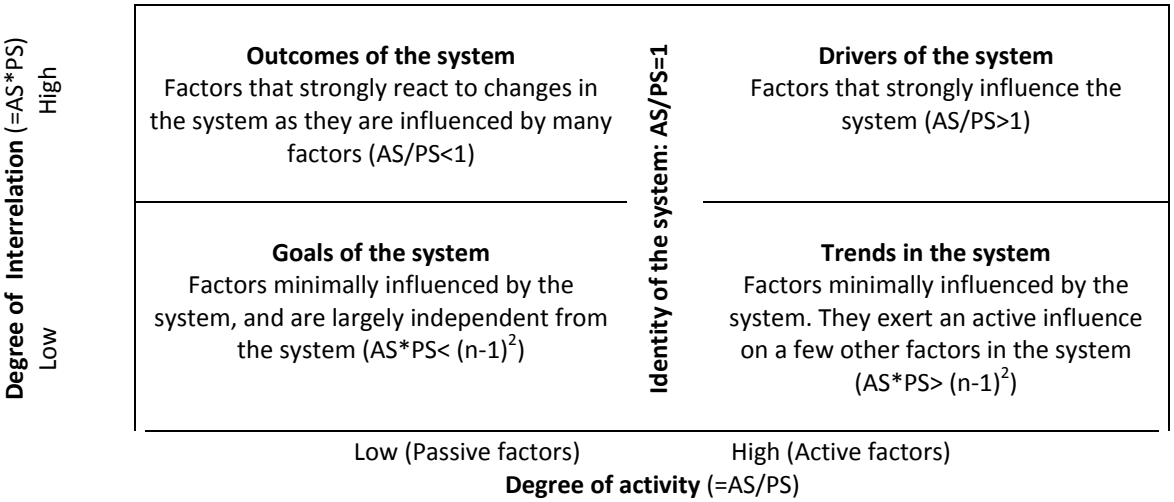

Figure 1: Interpretation of a factor's position in the map of interactions

The map of interactions depicting ICT value creation system in Organisation B is presented in Figure 2 below.

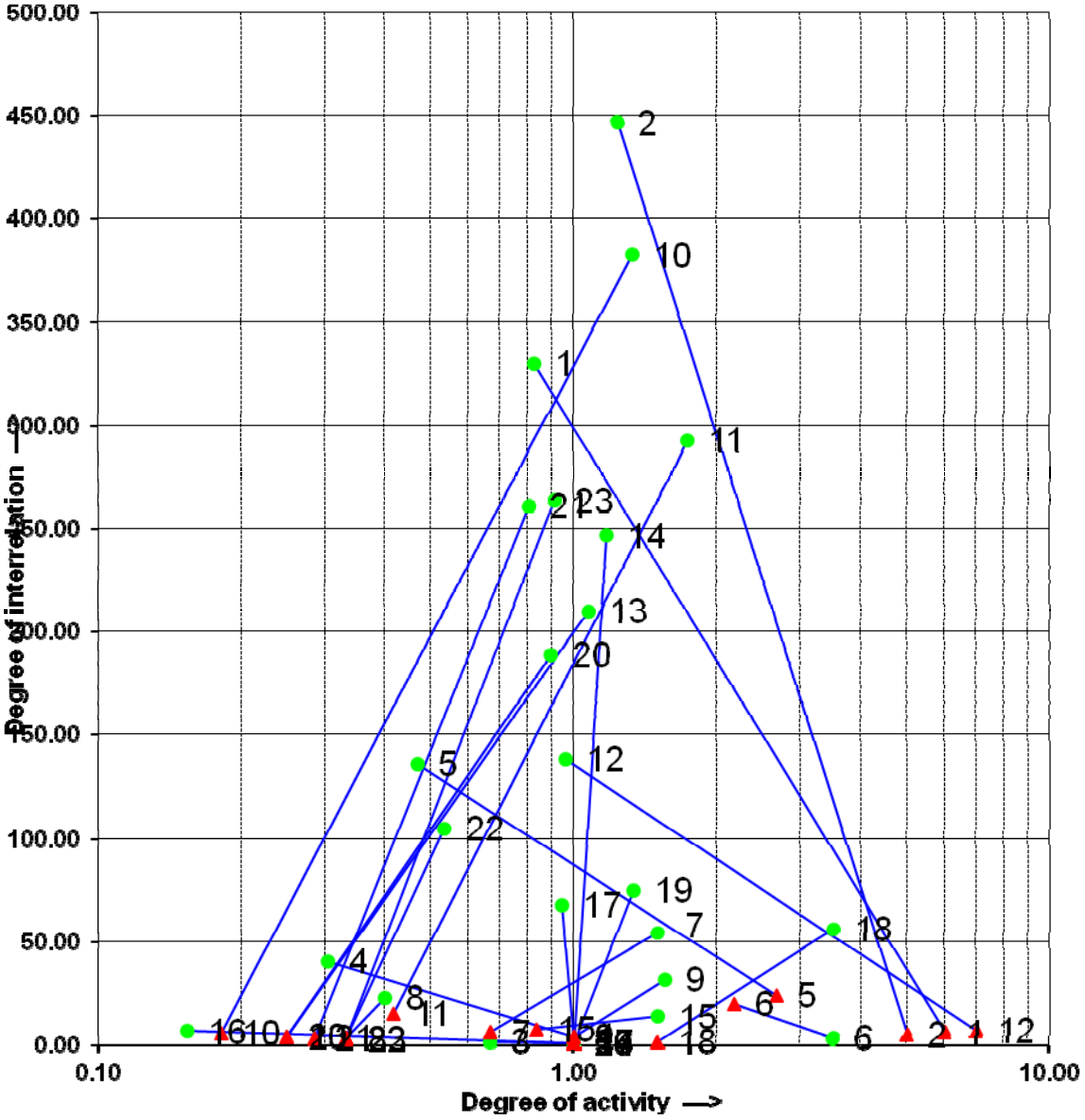

Figure 2: Map of interactions: Visual representation of ICT value creation system in Organisation B

Note: Elements of the ICT value creation system identified in Figure 2 are numerically coded (see Appendix 2).

The position of each factor in the map of interactions denotes its characteristic behaviour in relation to all other factors, that is, the system as a whole. The position of factors in the map of interactions in Figure 2 depicts the role of each factor in the ICT value creation system in Organisation B. This is further discussed next.

3.3 Functional roles of system's elements

3.3.1 Drivers of the ICT value creation system

Active and highly interrelated factors are positioned in the upper right quadrant of the coordinate system and are classified as *drivers* of the system. As they have a strong influence on the system, larger than the influence the system exerts on them, change in one of these factors will lead to change in the rest of the system. The higher their degree of interrelation, the quicker and less controllable their influence is.

The most interrelated drivers of the ICT value creation system, depicted in Figure 2, are ICT compatibility (F2), managers' support (F10), and organisational strategies (F11). Interviewees recognised that lack of ICT compatibility in the Organisation B is a major problem, and that managers were largely unaware of ICT

importance and its role in achieving the organisational strategies focused on expansion and growth. However, due to change in the organisational strategies from expansion to collaboration and strategic partnerships, managers are starting to recognise the role of ICT in this process. As the main drivers of the system are changing, the structure of the system captured in the map of interactions is changing as well.

Additional drivers, albeit with lower degree of interrelation, are factors IT support (F13) and alignment between ICT and organisational strategies (F14). These factors are in the transition period as well. The organisation employed an IT expert to integrate existing ICT applications, and to align ICT and organisational strategies. It seems that IT support is the critical factor for making the transition of the system to supporting new organisational strategy successful. Thus, it is important for the management of the organisation to provide all possible support to the new IT manager.

Drivers are a source of instability for the system, and thus, they need to be carefully influenced with particular awareness of their impact on the rest of the system.

3.3.2 Outcomes of the ICT value creation system

Factors classified as *outcomes* of the system are important indicators of the system's change and transformational processes. As they are passive but well interrelated with other factors, they are sensitive and highly responsive to changes in the system.

The most sensitive outcome in the ICT value creation system is ICT integration (F1), followed by strategic ICT effects (F21), and transformational ICT effects (F23). As a result of previous balance of the system, where ICT potential has not been recognised, ICT applications within the company are not integrated, causing issues in availability of information and collaboration among departments. In addition, the above described situation was acceptable to the management as it created strategic ICT effects, which were relevant for the organisation's expansion strategy. As the system is in the state of transition, it is expected that the identified outcomes will change.

Less interrelated outcomes of the ICT value creation system in Organisation B, are ICT use (F5), organisational culture (F12), informational ICT effects (F20), and transactional ICT effects (F22). These factors will need more influence and time to change. For example, a lack of ICT integration and compatibility influences ICT use, that is, employees need to transfer information from one system to another manually. Organisational culture, characterised by an ad hoc approach to organisation and planning, is influenced by differences among departments in terms of ICT applications, as these inhibit integration and automation of business activities.
All four categories of ICT effects are the outcomes of the system. This demonstrates that, ICT value is created and determined by the interactions in the system. The ICT value creation system in Organisation B is inhibiting realisation of informational, transactional and transformational ICT effects, which is linked to the lack of compatibility and integration of ICT applications, and lack of managers' awareness of ICT importance in achieving organisational goals.

3.3.3 Identity of the ICT value creation system

Factors that determine the essential *identity* of each system are positioned on the central vertical line in the map. They are neutral factors as the forces in the system balance out any influence these factors exert or receive from other factors in the system. Thus, they cannot be used as either drivers or indicators (Linss and Fried, 2010).

There is no identity for the presented ICT value creation system, which implies that the system is in a state of transition and change. Based on the interview evidence, the system is indeed in the state of transition. As mentioned earlier, the organisation is changing its strategies, managers are becoming aware of the importance of ICT, and a new IT manager recently employed to integrate ICT applications, and consequently, improve ICT value through increasing automation of business processes, making information available, and data sharing possible, and to increase the system's support in achieving organisational goals.

3.3.4 Goals of the ICT value creation system

Passive factors with low degree of interrelation are classified as *goals* of the system. They have a minimal influence on the system, and the system has a weak influence on them. Due to aloofness of these factors, influencing them directly would not translate in any improvement in the functioning of the system.
In the case of the ICT value creation system in Organisation B, goals are suppliers (F17), ICT user friendliness (F4), employee's ICT attitudes (F8), customers (F16) and ICT openness (F3). This indicates that the structure of the system and interactions among its elements produce satisfying collaboration with suppliers and customers, and strengthen employees' attitudes towards ICT and ICT use, as well as ICT applications that are not open for further adaptations.

3.3.5 Trends of the ICT value creation system

Although *trends* in the system are active factors, they also have a very low degree of interrelation and consequently, have a very weak impact on the system. These factors are working behind the scenes and they drive the evolution and development of the system.Trends in the system shown in Figure 2 are trends in the market (F18), partner company (F19), employees' ICT knowledge (F7), managers' ICT knowledge (F9), ICT seminars (F15), users' age and previous experience (F6). Based on the understanding that most of these trends are not positive, that is, many employees lack ICT experience, and struggle with using ICT, ICT education is lacking so employees rely on each other to learn to use ICT functions, managers are not knowledgeable in ICT either, the system may become a legacy system if the status quo is supported.

The effects that drivers have on the system are noticed over a long period of time. Organisation B needed to use a specific ICT application in order to maintain its collaboration with the partner company. Although this ICT application is aligned with the partner's IS, it was not integrated with the rest of the Organisation B's ICT applications. In fact, it inhibited the organisation from purchasing a new ICT application that could be integrated with other ICT applications, as the latest IS is not aligned with the partner's IS and does not support data sharing between the two organisations.

3.3.6 Structure of the ICT value creation system

The system analysed in this paper is in a state of transition, reflected in the fact that there are no factors determining the identity of the system. The structure of the system, illustrated in Figure 2, is pyramid shaped. Factors on the bottom of the map are spread along the x-axis, while factors on the top of the map are converging towards the middle line of the map. In other words, the higher the degree of interrelation (AS*PS), the smaller the degree of activity (AS/PS) for the elements of the system, and vice versa. This tells us that drivers and outcomes of the system are not well differentiated by the degree of activity. Thus, the transition of the system from previous state of ignoring ICT to new state where ICT importance is being recognised is somewhat difficult. This is further supported by the presence of 12 passive (AS/PS<1) and 11 active factors (AS/PS>1) in the system. Based on these findings, the organisation needs to influence the drivers of the system, in order to support change and the transition of the system towards a new balance.

3.4 Bringing together evaluation and management of the ICT value creation system

Evaluation of the ICT value creation system discussed above has important implications for managing the system at both individual and organisational levels. Based on the medium and strong interactions among the system's elements, indicated in the cross-impact matrices in Appendix 2, managers can identify factors that influence ICT use, and ICT effects as outlined in Tables 2 and 3. This should be a starting point for informed and appropriate management of ICT value.

The focus on the ICT use and ICT effects seem particularly important for management of ICT value. ICT use is largely determined by users' interaction with ICT applications (Davis, 1989; Venkatesh, Morris, Davis, and Davis, 2003), their ICT knowledge and their perception of the technological characteristics and organisational context. ICT use is an indicator of ICT success, as established in DeLone and McLean's (1992) model of IS success. The ICT literature has recognised the importance of ICT use as a 'missing link to ICT value' (Devaraj and Kohli, 2003). ICT use encompasses users' behaviour (DeLone and McLean, 1992), the degree and extent to which ICT is used to perform their work activities and business processes (Zhu and Kraemer, 2005). In the updated model, DeLone and McLean (2003) proposed that ICT use and user satisfaction influence overall ICT net benefits, that is, ICT value.

Table 2: Factors influencing ICT use in the ICT value creation system

Contexts	Factors influencing ICT use	Factor's functional role in the system
Technological	ICT integration	Outcome
	ICT compatibility	*Driver*
Individual	Users' ICT knowledge	Trend
Organisational	Organisational culture	Outcome
	IT support	*Driver*
	Alignment between ICT and organisational strategies	*Driver*
External Environment	Suppliers	Goal
	Trends in the market	Trend
	Partner company	Trend

The information in Table 2 confirms our earlier discussion on the ICT value creation system in Organisation B. It suggests that the lack of ICT compatibility and integration are the main inhibitors of ICT use in Organisation B. Information in Table 2 can be further used to manage and improve the ICT use. Management should consider using the drivers of the system, ICT compatibility, IT support and alignment between ICT and organisational strategies as part of the solution. This would mean investing in new IS and supporting the new IT manager with resources and ensuring his input and active role in the strategic decision making. It is expected that ICT use will change dramatically when ICT applications in the organisation are made compatible with one another, and when the alignment between ICT and organisational strategies is established. This will also positively affect the outcomes of the system, ICT integration and organisational culture. Suggested activities will affect users' ICT knowledge, organisation's impact on the market's trends and its relationship with the partner company.
ICT use influences three categories of ICT effects, namely, informational, strategic and transactional ICT effects, as indicated in Table 3. Clearly, managing ICT use at the individual level influences organisational level outcomes.

Table 3: Factors influencing ICT effects in the ICT value creation system

<table>
<tr><th rowspan="2">Groups of factors</th><th colspan="4">ICT effects</th><th rowspan="2">Factor's role in the system</th></tr>
<tr><th>Informational</th><th>Strategic</th><th>Transactional</th><th>Transformational</th></tr>
<tr><td>Technological</td><td colspan="3">ICT integration
ICT compatibility</td><td></td><td>Outcome
Driver</td></tr>
<tr><td>Individualistic</td><td colspan="2">ICT use</td><td></td><td>None</td><td>Outcome</td></tr>
<tr><td rowspan="2">Organisational</td><td colspan="3">Managers' ICT knowledge
Managers' support
Organisational strategies
Organisational culture
Alignment between ICT and organisational strategies</td><td></td><td>Trend
Driver
Driver
Outcome
Driver</td></tr>
<tr><td colspan="3"></td><td>IT support</td><td>Driver</td></tr>
<tr><td>External environment</td><td>None</td><td>Partner company</td><td>None</td><td>None</td><td>Trend</td></tr>
<tr><td rowspan="2">ICT value</td><td>None</td><td colspan="2">Informational ICT effects</td><td>Strategic ICT effects</td><td>Outcome</td></tr>
<tr><td></td><td colspan="2">Transactional and Transformational ICT effects</td><td></td><td>Outcome</td></tr>
</table>

ICT integration and ICT compatibility inhibit creation of ICT value in the Organisation B. Organisational factors identified in Table 3 influence all four categories of ICT effects. As the system is in the state of transition, the following organisational factors, drivers of the system, are of particular importance for managing the ICT value creation system: managers' support, organisational strategies and alignment between ICT and organisational strategies. Managers' ICT knowledge may inhibit this process in the short run, and may change in the long run. Again, IT support is the critical element in bringing about the change in the system. Perceived importance of overall strategic ICT effects will contribute to the change in the system, although this is inhibited by the organisation's dependence on the partner company.

4. Conclusion

Using a case study approach, the cross-impact analysis has been applied to achieve the objective of the paper. The method clearly demonstrates the critical role of ICT evaluation in managing ICT value, and brings together these two processes. Evaluation of ICT value has an important contribution for ICT management when it considers interactions and synergies among technology, people and organisational context. Interactions among these contexts are the essential mechanism for ICT value creation (Nevo and Wade, 2010).

The evaluation of the ICT value creation system in Organisation B is based on the understanding of the functional position of the system's elements and their subsequent classification as drivers, outcomes, identity, goals, and trends. This information seems particularly relevant for managing and improving the process of ICT value creation. That is, the element's position in the system determines its usability in managing the system. Findings from a cross-impact analysis can be used to manage the system by influencing its drivers and observing the outcomes to understand the magnitude and speed of the change in the system. This is important information for managing the system in terms of bridging discrepancies between a system's actual and desired state. The findings demonstrate that a specific combination of system's elements, reflected in the functional position of the elements in the system, determines the system's behaviour as well as ICT value. Engaging in ongoing ICT evaluation in the post-implementation period can provide insights for managing and creating ICT value, and assist in achieving strategic organisational objectives.

Although the findings in this paper are based on a single case study, the mechanism through which ICT value emerges can be further applied more generally to IS management practice. First, practitioners need to understand the system and its elements, and second, take into account the underlying assumption of systems theory that change in one part of the system produces changes in the rest of the system. Influencing one part of the system, without considering the system as a whole, can often produce unexpected results and ICT value that is often different from the expected one. ICT evaluation needs to reflect interdependencies among the system's elements rather than consider ICT as a separate entity.

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Appendix 1: Factors describing the ICT value creation system in Organisation B

Table A1.1: Factors describing the ICT value creation system in Organisation B

Code for factors	Factors	Indicative quote from interviewees*
Technological context		
F1	ICT integration	"It is hard to have control over something when it is disintegrated" (M-S). IT1: "ICT implementation was done in stages by different providers in each department". M-M: "this is the reason ICT applications are not integrated into complete information system".
F2	ICT compatibility	"The whole IS is totally in disarray" (IT-M).
F3	ICT openness	Only one ICT application was emphasised as being open. Most of ICT applications are old and not open or compatible (IT1).
F4	ICT user friendliness	ICT recognised as user friendly as users developed a habit of using the same ICT applications. IT2: "people know how to work with the tools which are available to them, so they do not have to invest their time on learning new things".
Individual context		
F5	ICT use	"Technologically everything functions more or less...employees have a routine way of doing things, they do not have to do something complicated, but as simple as possible with the most effects" (IT2).
F6	Users' age and previous ICT experience	"For older users ICT is a necessary evil, and a lot of them do not know how to use Internet and emails and they do not have a lot of practice and experience with it" (E-M1).
F7	Users' ICT knowledge	Both IT1 and IT2 agreed that employees' ICT knowledge was very low.
F8	Users' attitudes toward ICT	Marketing manager (M-M) described his view on the general ICT attitude in the company: "Employees are reluctant to use ICT and to change their habits caused by ICT."
Organisational context		
F9	Managers' ICT knowledge	E-M1: members of BoD are "older and ICT is a new thing for them." IT2 on BoD's support to ICT: "people who did not use ICT cannot understand the importance of buying new computers and ICT".
F10	Managers' support	"without any strategy or planning…and the BoD had no knowledge or interest in what they were doing (ICT implementation)" (BoD3). E-J1 explained the BoD had great influence on ICT in the company "what they decide, that is how it is".
F11	Organisational strategies	"in the last five years organisational strategy was expanding sales by over 300%" (BoD1), there was no time for keeping track of IT/ICT. Naturally, this led to implementing *ad hoc* ICT solutions, which BoD2 noted "so the(IT) strategy was that when the problem arose we would fix it. There is no real plan or strategy just *ad hoc* reaction to the problem" (BoD2).
F12	Organisational culture	"The BoD works by deadlines, there is no precise, concrete communication with others so there is a lack of clear vision of where the company is heading to, nobody knows what they are supposed to do" (IT-M). "I waste a lot of time…everything is delayed until the last minute…it is a take- it- easy approach, we will take care of it later" (IT-M).
F13	IT support	IT1 observed that employees called for IT support all the time. "If the managers were aware of the costs of IT support, employees would have to actually learn to use ICT on their own" (IT1). IT employees lack formal IT education, and were educated "inside the company" (BoD2) and therefore "we did not have a skilled IT workforce" (BoD2).
F14	Alignment between ICT and organisational strategies	BoD2: "as the company was developing so the IT/ICT problems have been fixed". "BoD should know what it can get from ICT, it should know how to ask for it and there should be trust between the BoD and IT department, which is not the case here" (IT1). The pattern is to invest in ICT to make it functional in the short term, which increases the gap between ICT functions and organisational objectives in the long run.
F15	ICT seminars	E-J2: "there is no need for ICT seminars since there are no changes in the ICT".

External environment		
F16	Customers	Organisation has the monopoly position in the market.
F17	Suppliers	M-S: "the ICT used in this department was recently implemented to be compatible with the main supplier".
F18	Trends in the market	"if we need something, we try to get it, and if everybody is having more advanced ICT we must have it…we do as our competitors do, it is the law of the market and we have to follow" (E-M1).
F19	Partner company	ICT upgrades depend on the Partner Company: "We are now in limbo until that is solved" (M-M).
ICT effects		
F20	Informational	"People, who should have information to make decisions, do not have it. Therefore, everybody has a different partial picture on the situation in the company" (IT1). Information about sales outlet revenues were available a month and a half after their occurrence, which diminished the control over operations in the sales outlets. Making decisions based on the old reports and analysis created blind spots for possible opportunities in the market.
F21	Strategic	(M-M) explained decisions in Eagle "are not based on appropriate and on time information, but on the past period's analysis". Employee E-S further explained special applications have been developed that enable ICT compatibility and data sharing with the supplier. Sales manager (M-S) proudly stated that their ICT was compatible with their major supplier. According to E-M, it also helped to keep up with the increased work load and the market changes.
F22	Transactional	Lack of complete and on time revenue information, and lack of inventory control. Lack of information needed for proper decision making lead to running unprofitable business. Due to partial development and integration of accounting software, data had to be re-entered manually in the system resulting in doubling the work and costs, as explained by M-A. New ICT application brought positive transactional ICT effects (M-M, E-S): improved productivity by reducing the number of employees and speeding up the work. Marketing manager explained it reduced the time needed for doing their work "things we use to do in eight days, we are now doing in three days" (M-M). In contrast, Sales manager (M-S) explained that not adopting and implementing electronic cash registers created several issues- the lack of control of sale outlets, old information and consequently higher costs. M-S concluded: "Without this software it would be hard for us to achieve the results".
F23	Transformational	ICT was implemented and used in an ad-hoc way when the business need arose, so it was made to fit specific activities, rather than using its possibilities to fit the business processes around them. Thus, ICT applications inhibit realisation of transformational ICT effects.

Note: *E= employee; BoD= member of Board of Directors; M=manager; M-S= manager of the sales department; M-M= Manager of the marketing department; M-A=manager of the accounting department.

5. Appendix 2: Cross-impact matrices

Table A2.1: Positive cross-impact matrix

		Organisation B: Positive cross-impact matrix																								
		Effect factors																						Active	Quotient	Ratio
Cause Factors		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**AS**	**Q=AS/PS**	**R=AS*PS**
ICT integration	**1**	1	1		2	1			0.5				1		0.5			1		0.5	2	2	2	2	16.5	**0.83**	**330.00**
ICT compatibility	**2**	2	1		1	2			1				2	2	2		1	1		0.5	2	2	2	2	23.5	**1.24**	**446.50**
ICT openness	**3**			1																					1.0	**0.67**	**1.50**
ICT user friendliness	**4**				1	0.5		0.5	1												0.5				3.5	**0.30**	**40.25**
ICT utilisation	**5**				2	1		1	1		0.5						0.5	1		1					8.0	**0.47**	**136.00**
Users' age and previou	**6**						1						2	0.5											3.5	**3.50**	**3.50**
Users' ICT knowledge	**7**				2	1		1	1				1	0.5		1		0.5			0.5	0.5			9.0	**1.50**	**54.00**
Users' attitudes towarc	**8**				0.5			0.5	1		0.5		0.5												3.0	**0.40**	**22.50**
Managers' ICT knowled	**9**									1	2										1	1	1	1	7.0	**1.56**	**31.50**
Managers' support	**10**	2	2		0.5			0.5	0.5		1	0.5	2	1	2	0.5		1		1	2	2	2	2	22.5	**1.32**	**382.50**
Organisational strateg	**11**	2	2								2	1	2	2	2	0.5	1	1	2		1	1	1	2	22.5	**1.73**	**292.50**
Organisational culture	**12**	2	2			2.0			1		1	0.5	1	1	0.5		0.5								11.5	**0.96**	**138.00**
IT support	**13**	2	2		0.5	1		0.5		0.5	1	2		1	1						0.5	0.5	0.5	2	15.0	**1.07**	**210.00**
Alignment between ICT	**14**	1	1			2					1	2		1	1						2	2	2	2	17.0	**1.17**	**246.50**
organisational strategi	**15**				2	0.5		0.5								1					0.5				4.5	**1.50**	**13.50**
ICT seminars	**16**																1								1.0	**0.15**	**6.50**
Customers	**17**	1				1		0.5		0.5	1	1					0.5	1	1	0.5					8.0	**0.94**	**68.00**
Suppliers	**18**	1		0.5		1				0.5	2	2		1	2		1	1	1	1					14.0	**3.50**	**56.00**
Trends in the market	**19**	2	2			2		0.5		0.5	0.5									1	0.5	1			10.0	**1.33**	**75.00**
Informational ICT effects	**20**	0.5	1			1		0.5	0.5	0.5	0.5		0.5	1	0.5		0.5	0.5		1	1	1	2	0.5	13.0	**0.90**	**188.50**
Strategic ICT effects	**21**	0.5	2			1					2	2		0.5	0.5		0.5	0.5		1	0.5	1	0.5	2	14.5	**0.81**	**261.00**
Transactional ICT effects	**22**	1	1							0.5				0.5	0.5						0.5	2	1	0.5	7.5	**0.54**	**105.00**
Transformational ICT effects	**23**	2	2							0.5	2	2		2	2							2		1	15.5	**0.91**	**263.50**
Passive sum	**PS:**	20.0	19.0	1.5	11.5	17	1.0	6.0	7.5	4.5	17.0	13.0	12.0	14.0	14.5	3.0	6.5	8.5	4.0	7.5	14.5	18.0	14.0	17.0	252.5		

Note: Colour scheme was used to visually identify the strong (value 2, darker shading) and moderately strong interactions (value 1, light shading)

Table A2.2: Negative cross-impact matrix

		Organisation B: Negative cross-impact matrix																								
		Effect factors																						Active	Quotient	Ratio
Cause Factors		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**AS**	**Q=AS/PS**	**R=AS*PS**
ICT integration	**1**	1									2	2		1											6.0	**6.00**	**6.00**
ICT compatibility	**2**		1								2	2													5.0	**5.00**	**5.00**
ICT openness	**3**			1																					1.0	**1.00**	**1.00**
ICT user friendliness	**4**				1		0.5							0.5											2.0	**1.00**	**4.00**
ICT utilisation	**5**					1	0.5							1		2					1	1	1	0.5	8.0	**2.67**	**24.00**
Users' age and previou	**6**				1	1	1	1	1	1	0.5														6.5	**2.17**	**19.50**
Users' ICT knowledge	**7**						1	1																	2.0	**0.67**	**6.00**
Users' attitudes towarc	**8**								1																1.0	**0.33**	**3.00**
Managers' ICT knowled	**9**									1		1													2.0	**1.00**	**4.00**
Managers' support	**10**										1														1.0	**0.18**	**5.50**
Organisational strateg	**11**					1						1										0.5			2.5	**0.42**	**15.00**
Organisational culture	**12**							1					1								2	1	1	1	7.0	**7.00**	**7.00**
IT support	**13**													1											1.0	**0.25**	**4.00**
Alignment between ICT	**14**														1										1.0	**1.00**	**1.00**
organisational strategi	**15**								1					0.5		1									2.5	**0.83**	**7.50**
ICT seminars	**16**																1								1.0	**1.00**	**1.00**
Customers	**17**																	1							1.0	**1.00**	**1.00**
Suppliers	**18**																		1					0.5	1.5	**1.50**	**1.50**
Trends in the market	**19**																			1					1.0	**1.00**	**1.00**
Informational ICT effects	**20**																				1				1.0	**0.25**	**4.00**
Strategic ICT effects	**21**																					1			1.0	**0.29**	**3.50**
Transactional ICT effects	**22**																						1		1.0	**0.33**	**3.00**
Transformational ICT effects	**23**																							1	1.0	**0.33**	**3.00**
Passive sum	**PS:**	1.0	1.0	1.0	2.0	3	3.0	3.0	3.0	2.0	5.5	6.0	1.0	4.0	1.0	3.0	1.0	1.0	1.0	1.0	4.0	3.5	3.0	3.0			

Note: Colour scheme was used to visually identify the strong (value 2, darker shading) and moderately strong interactions (value 1, light shading)