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DETERMINING THE COST OF BUSINESS CONTINUITY MANAGEMENT

A Case Study of IT Service Continuity Management Activity Cost Analysis

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Kimmo Syrjänen

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University of Turku

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Department of Management and Entrepreneurship
Information Systems Science
Doctoral Programme of Turku School of Economics

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– To my Family and Friends –

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ABSTRACT

This single organisation case study discusses the cost of business continuity management in IT services. Information technology (IT) expenses can amount to a substantial part of operational costs in a company, and IT leaders tend to aim for thorough IT cost management to meet financial targets. Thus, information security activities such as business continuity management (BCM) rank among the most important concerns for IT leaders. Despite the concerns of IT management, senior management appears to be hesitant to spend on BCM as much as IT management would hope for. Senior management may struggle with the question of how to justify spending on an activity that proves its usefulness only when a rare event occurs. The challenge for measuring costs of sociotechnical activities was the inspiration for this work – to find out whether the cost of business continuity management (BCM) could be explained better to help decision making.

Two main paradigms emerged from literature – BCM activities in the context of organisational routines, and IT cost and information security cost classifications. The theoretical assumption was that the relationship between IT costs and BCM activities emulates the activity-based costing theory (ABC) – the premise of cause-and-effect relationship between activities and costs. The key question is "*How to determine the cost of BCM activities in IT services?*" To find out, I used comprehensive archival data set from a case company and designed a retrospective quantitative model to analyse the association between BCM activities and IT costs. By employing causal-comparative method and multiple linear regression analysis, I compared distinct groups of IT services to determine how much of the variation in IT costs could be explained by BCM activities. In addition, I measured the relative effect of each independent variable towards the total cost of BCM. As both statistical and practical significance test results were supported, several interesting results were observed between BCM activities and IT costs – namely human, technology and organisational resources, as well as IT service designs.

The research presents two theoretical contributions and one empirical contribution to the theory. The first and primary contribution is the BCM activity cost model. This is the final product for the main research question of determining the cost of BCM in IT services. The second contribution is the total cost of BCM framework. This framework contributes to the broader academic discussion of information system (IS) cost taxonomies in IT services and information security. The third contribution is empirical confirmation how to observe unknown cost effects by multiple regression analysis. Learnings from this research can contribute IS researchers focused on the economic aspects of IS and IT.

The research also introduces three practical contributions. The first one considers the observation of overall BCM cost effects on IT services. Although the results of a single case study cannot be generalized directly to every organization, information herein may aid companies to evaluate BCM impact on their budgets. The second practical contribution considers the challenges regarding measurement of activity costs that can be difficult to observe directly. Within the limitations of this research, nothing here suggests that the BCM activity cost model could not be productized and integrated into other cost appraisal tools in a company or applied in other IT service management areas. The last important practical contribution are the definitions of BCM activity cost variables. Confirming the cost association between theoretical and empirical BCM frameworks can help BCM professionals to promote BCM process.

KEYWORDS: Business Continuity Management, IT service cost(s), Economics of Information Security, Organisational routines, Activity Based Costing, Multiple Regression Analysis

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TIIVISTELMÄ

Tämä yhden organisaation tapaustutkimus pohtii jatkuvuudenhallinnan kustannusten osuutta tietojärjestelmäpalveluissa. Informaatioteknologian (IT) kustannukset saattavat muodostaa merkittävän osa yrityksen menoista, ja IT-johtajat pyrkivät yleensä tarkkaan kulujenhallintaan saavuttaakseen yrityksen taloudelliset tavoitteet. Siksi tietoturva-aktiiviteetit kuten jatkuvuudenhallinta (business continuity management, BCM) ovat heidän olennaisimpia huolenaiheitaan. IT-johtajien huolista huolimatta ylin johto ei yleensä ole kovin innokas panostamaan BCM:ään niin paljon kuin IT-johto toivoisi. Ylin johto saattaa tuskailla sen kanssa, miten perustella kulut toimiin, joita kaivataan vain harvinaisissa poikkeustilanteissa. Sosioteknisten kulujen mittaamisen haaste antoi inspiraation tälle tutkimukselle; tavoite oli selvittää, olisiko mahdollista selittää BCM-kustannuksia paremmin päätöksenteon tueksi.

Kirjallisuudesta nousee esiin kaksi keskeistä aihepiiriä: BCM organisaation toimintatapojen kontekstissa sekä IT- ja tietoturvakulujen luokittelu. Teoreettinen oletus oli, että IT-kulujen ja BCM-toimenpiteiden suhde emuloi toimintolaskennan (activity-based costing, ABC) teoriaa – se, että toimenpiteiden ja kulujen välillä on syy-seuraussuhde. Avainkysymys on ”Miten määritellä BCM-toimenpiteiden kulut IT-palveluissa?” Tämän selvittämiseksi käytin kattavaa arkistodataa case-yhtiöstä ja kehitin retrospektiivisen kvantitatiivisen mallin analysoidakseni BCM-toimenpiteiden ja IT-kulujen suhdetta. Kausaalis-komparatiivisen metodin ja lineaarisen regressioanalyysin avulla vertailin erilaisia IT-palvelujen ryhmiä selvittääkseni missä määrin BCM-toimenpiteet voisivat selittää IT-kulujen vaihtelua. Lisäksi mittasin jokaisen muuttujan suhteellisen vaikutuksen BCM:n kokonaiskustannuksiin. Kun sekä tilastolliset että käytännölliset testitulokset huomioitiin, BCM-toimenpiteiden ja IT-kulujen suhteesta ilmeni useita kiinnostavia tuloksia: sekä inhimillisiä että teknologia- ja organisaatioresursseihin ja IT-palvelujen muotoiluun liittyviä.

Tutkimus tuotti kaksi teoreettista kontribuutiota sekä yhden empiirisen todistuksen teorialle. Ensimmäinen ja olennaisin näistä on BCM-toimenpiteiden kustannusmalli. Tämä lopputuotos vastaa tutkielman avainkysymykseen BCM-kuluista IT-palveluissa. Toinen kontribuutio on BCM-kehyksen kokonaishinta. Tämä voi ruokkia laajempaa akateemista keskustelua tietojärjestelmien (information system, IS) kustannustaksonomioista IT-palveluissa ja tietoturvassa. Kolmas kontribuutio, empiirinen todistus, osoittaa epäsuorien kulujen mittaamisen olevan mahdollista regressioanalyysiä hyödyntäen. Tutkimuksen havainnoista voi olla hyötyä IS:n ja IT:n taloudellisiin aspekteihin keskittyneille IS-tutkijoille.

Tutkimuksesta nousee esiin myös kolme käytännön kontribuutiota. Ensimmäinen liittyy siihen, miten BCM-kokonaiskulujen vaikutuksia IT-palveluihin seurataan. Vaikka yhden tapaustutkimuksen tuloksia ei voida yleistää, tutkimuksen havainnot voivat auttaa yrityksiä arvioimaan BCM:n vaikutuksia budjetteihinsa. Toinen käytännön kontribuutio liittyy haasteisiin siinä, kuinka mitata toimenpidekustannuksia, joita on hankala tarkkailla suoraan. Tämän tutkimuksen rajoissa ei ilmennyt mitään syytä sille, etteikö BCM-toimenpiteiden kustannusmallia voitaisi tuotteistaa ja integroida yrityksen muihin kustannusarviotyökaluihin tai etteikö sitä voisi soveltaa muille IT-palvelujen hallinnon alueille. Viimeinen merkittävä käytännön kontribuutio on BCM-toimenpiteiden kustannusmuuttujien määrittely. BCM-ammattilaiset voivat helpommin edistää BCM-prosessia, kun teoreettisten ja empiiristen BCM-kehysten kulujen vastaavuus vahvistetaan.

ASIASANAT: Liiketoiminnan jatkuvuudenhallinta, IT palvelukustannukset, Tietoturvallisuustalous, Organisaatio rutiinit, Toimintolaskenta, Multiple Regression Analysis

Acknowledgements

When I began my doctoral research journey in 2013, little did I know my research topic would become so relevant. It is 2022, and as I am drafting this chapter, the world is recovering from an unprecedented pandemic. Supply chain disruptions have slowed economic growth of major industries, and geopolitical storms are emerging around the globe. Consequently, business continuity management is a crucial topic for companies and societies, as uncertainties are not getting any lesser in our complex, interconnected world.

What a journey it has been. It would not have been possible without support from so many people. From home, from work, and from the research community. First, I want to thank the University of Turku and the School of Economics for granting me the resources and the support to complete my research. I am honoured to be Alumnus of the University, and I am looking forward to giving back what I have received from you.

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Berlin, June 20th 2022
Kimmo Syrjänen

KIMMO SYRJÄNEN
Kimmo Syrjänen is a researcher at Turku School of Economics, University of Turku. His research is focusing on economics of information systems and security. His methodological approaches include case study, causal-comparative and quantitative methods. He has also over 20 years working experience in risk and information security management.

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1 Introduction

At one moment, we are feeling comfortable, safe and secure, but then, in seconds, daily routines transform into chaos as the most unlikely scenario becomes reality. Some of those who are in the middle of a disaster event may alert and act, while others perhaps freeze or panic. The first responders arrive soon after receiving the alert, invoking the emergency procedures, rescuing and limiting damages. Initial steps to disaster recovery and returning to normal operations can begin soon after the disaster is brought under control.

History has taught us that disasters manifest themselves in numerous ways – from human tragedies to economic losses – as shown by tragedies like 9/11, the Northeast blackout and Fukushima, among many others (Eshghi & Larson, 2008; Falkenrath, 2005; Minkel, 2008; Steinhauser et al., 2014). The global database of natural and technological disasters comprises records of 21000 events since 1900 (Database | EM-DAT 2018). These records indicate that since 1990 disasters have affected a growing number of humans' lives and their costs are increasing annually, even though the number of disasters does not trend up. In 2016, 569.4 million people i.e. 17.3% of all global population were affected by natural incidents; economic losses estimated to 154 billion USD, that is 12% above the annual average since 2006 (Guha-Sapir, 2017). Looking at 2020 numbers, the economic impacts do not show signs of declining (Centre for Research on the Epidemiology of Disasters & UN Office for Disaster Risk Reduction, 2021)

According to the World Economic Forum's Global Risk Report (World Economic Forum, 2021), societies and companies are at risk to effects of extreme weather conditions and natural disasters due to the concentration of population in megacities and urban areas. Furthermore, globally connected interdependent services, systems and users are exposed to uncontainable interruptions and disruptions, since what happens to one infrastructure can directly and indirectly affect other infrastructures, impact large geographic regions and send ripples throughout the national and global economy (Laugé et al., 2015; Rinaldi et al., 2001). Natural hazards and human errors are not the only risks our connected world is facing, as for both organized criminals and random hackers, interconnected systems provide monetization opportunities by blackmailing to disclose vulnerable systems to the public, hacking into the system, altering the data, stealing valuable information or using ransomware that encrypts company data until ransom has been paid by the victim company (Anderson, 2006; Cerullo & Cerullo, 2006; Edwards et al., 2016). In a worst case scenario, highly skilled and motivated hackers could launch advanced attacks on critical infrastructure like power utility systems that would trigger snowballing events of interruptions, escalating on nationwide interruption of service availability which could even cause fatalities (Alcaraz, 2015; Bruijne & Eeten, 2007; Rinaldi et al., 2001). We may not be able to avoid many forms of critical events, but we may prepare for the worst and if well prepared, perhaps take the hit and survive.

We are living in the age of fourth industrial revolution (Lasi, 2014) with inexhaustible opportunities to capture our reality by data and advanced computing (Nunan, 2017). Albeit the unpresented availability of data and sophisticated forecasting techniques, the lack of evidence of accurate forecasting suggests that the predictability of rare and high impact events has noteworthy limitations (Goodwin & Wright, 2010). While disasters may be rare (Post & Diltz, 1986) and complexity does not lead every organization into crisis inherently (Hopkins, 1999), risks of disruptions are real in both realms, the cyber and physical world (Anderson, 2019; Guha-Sapir, 2017). Since forecasting brings little or even no light to future disasters, organizations can embrace awareness of critical events and invest in resilient and flexible business operations to ensure continuity of business (Goodwin & Wright, 2010).

Business continuity management (BCM) is developed from disaster recovery planning into the process through which organizations can recover from the disruptions caused by nature or humans, such like building fire, flooding, utility failure, terrorism, disease outbreaks, information systems failure and supply chain interruptions (Faertes, 2015; Herbane et al., 2004; Zsidisin et al., 2005). When embedded into organizational culture, BCM can help organizations to build the capability to respond and sustain business operations when disaster or major disruption occurs. Overall, it can be described as a business-centric, socio-technical and cross-functional management activity to establish proactively an embedded capability to respond to anticipated incidents e.g. Herbane (2010). The scope of this research is on one area of BCM – IT continuity management.

The objective of BCM in IT is to guarantee pre-determined minimum level of IT service based on the business impact analysis; that is a method to estimate negative effects to business caused by potential incidents (Chow, 2009; Wan, 2008). Depending on the context of business and the risk appetite, a company may choose diverse combinations of both technical and non-technical business continuity solutions, from lower-priced single service data back-up solutions to the high-cost regional data centers with regularly tested highly reliable 24/7 IT services as well as reciprocal agreements between organizations and documented plans (Bajgoric, 2010; Boddy, 2008; Mahdy, 2001; Shropshire & Kadlec, 2009). Beside an increased level of resilience against major incidents, BCM can have a positive effect on the organizational and technical reliability and hence affect the quality of information systems and services (Asgary, 2011; Butler, 2006; Gorla, 2010; Herbane, 2010; Hoong, 2014; Iwai, 2008; McDonald, 2008). Reliability is an important factor for IT service quality and such trustworthy information services can positively impact the overall success of information systems (DeLone & McLean, 2003; Gorla et al., 2010; Kettinger & Lee, 1997; Mithas et al., 2011; Parasuraman et al., 1988; Pitt et al., 1995).

Considering the threat landscape and business dependency on IT, it is not surprising that alongside IT leaders' continuous concerns regarding business alignment, cost management and cyber security, business continuity management is amid the most important concerns of IT leaders (Kappelman, 2020). Exercised capability to respond and recover swiftly in disasters may not only preserve value (Herbane et al., 2004) and secure revenue stream, but also prepare the management for successful crisis management that may increase the shareholder trust and value (Knight et al., 1997). Despite the regulative pressure (Braun, 2007) and concerns of IT management, senior management appears to be hesitant to spend on BCM on a level anticipated by the IT management (Kappelman, 2020). IT costs can be a substantial part of cost of operations affecting the company's financial performance. Thus, senior management might struggle with the question of how to justify spending on an activity that demonstrates its usefulness only when a rare event occurs (Knight et al., 1997; Brynjolfsson & Yang, 1996; Kite & Zucca, 2007; Seow, 2009; Momani, 2010). Kappelman et al.'s (2020) long term surveys suggest that IT leaders drive thorough cost management to meet profit targets set by the organization and at the same time, paradoxically, pursue to guarantee the availability of IT services under any circumstance. This pressure may explain why four out of ten key performance measures in IT leaders' agenda are related to costs – and the number one is systems uptime (Kappelman, 2020).

According to Cooper's and Kaplan's definition of profit being the total revenue minus the expenses (1992. 1998), it is not trivial to understand the cost effect to a profitable company. Consequently, determining cost taxonomies can be considered a compulsory element for the development of IT investments appraisal models (Irani et al., 2006; Irani & Love, 2000, 2002). Effective cost appraisal models may enhance decision making, secure savings in right places and eventually, the control over costs can cause positive organizational impact (King, 1978; Bannister, 1999; Gerlach, 2002; Neuman, 2004; Hochstein, 2005; Irani, 2006). We can assume that BCM does not differ from other management areas in an organization. Therefore, we can postulate that understanding the cost aspects of BCM may help IT management to plan on better accuracy and control costs to optimal range; all which may increase the senior management's confidence to invest in BCM.

Reflecting on the necessity for IT management to communicate cost effects of business continuity management to the senior management and the opportunity to develop the theoretical knowledge how to determine the respective cost aspects, this research attempts to answer the following key question: **How to determine the cost of BCM activities in IT services?** To find an answer to this main question, we seek to identify the proportional cost behavior of BCM activities through three sub-questions. The first question assumes that BCM is a combination of activities, e.g., Gibb (2006), Sheth (2008) and Randeree (2012), where each distinct activity causes costs in IT services. Therefore, we can ask: **How much of the IT service cost variation can be explained by BCM activities?** If we assume a causal relationship between BCM activities and IT costs, we can presume that BCM activities consume human, technology and relationship resources, e.g., hardware, software and working time of subject matter experts (Ross et al., 1996; Mahdy, 2001; Bajgoric, 2006; Walch & Merante, 2008; Shropshire & Kadlec, 2009). Consequently, we can ask the following question: **How much of the IT cost variation in IT resource types can be explained by the BCM activities?** IT organizations can apply BCM in IT service management on various means, depending on the corresponding organizational and technical circumstances (Herbane et al., 1997). Thus, the question is: **How much of the IT cost variation in the different IT service designs can be explained by BCM activities?**

A successful determination of costs would require a close observation of contemporary IT service continuity management; thus, our methodology follows the case study approach (Yin, 2014). The naturally occurring data was produced by the case company between years 2006 and 2012. Comprehensive archival data set encouraged to design a retrospective quantitative model to analyze the relationship between BCM activities and IT costs. Data analysis employed the causal-comparative method (Salkind, 2010) and multiple linear regression modelling (Field, 2013; Hair, 2010; Tabachnick & Fidell, 2014). The causal-comparative approach supported archival based research, allowing to compare distinct groups of IT services in different contexts – with and without BCM activities (Figure 1). As the association between cost data and BCM variables was not directly observable, Multiple Linear Regression (MLR) analysis was used to determine how much of the variation in IT costs could be explained by BCM activities (Benston, 1966). In addition, this approach enabled the measurement of the relative effect of each independent variable on the proportionate cost of BCM activities. The relationships between IT costs, BCM activities and resources used for BCM at the company level were determined on the basis of the theoretical properties of Activity Based Costing (Cooper & Kaplan, 1988).

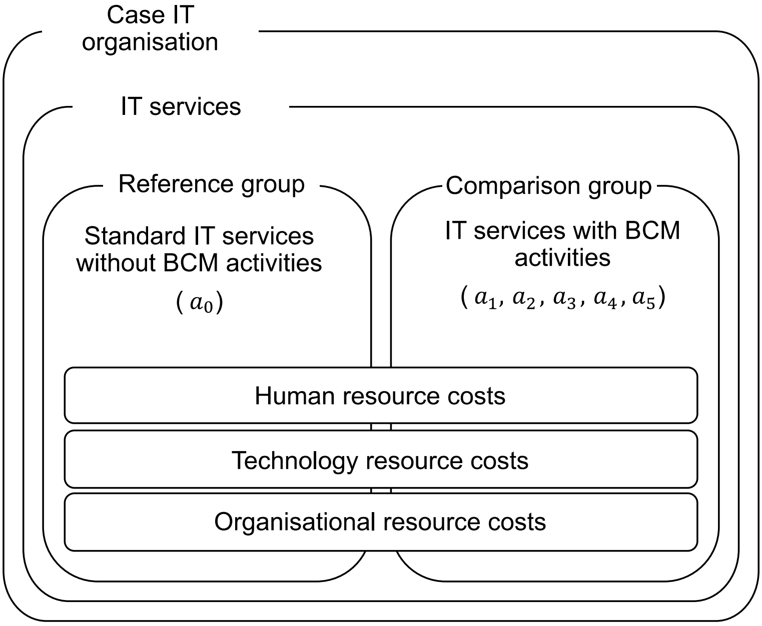

Figure 1. The research design.

The research is based on the premises that IT service requirements trigger activities in an organization. Each activity consumes resources due implementation of the requirements. As a result, costs are generated and associated to activities and back to IT services. It can be assumed that this general idea can be applied to BCM cost study too. To make this idea work, the total cost of business continuity framework was developed to explain the nature of BCM costs. Five BCM activity variables marked as a_1, a_2, a_3, a_4 and a_5 in the figure 1, were tested with three IT resource cost types, human, technology and organizational resources to observe the cost effects. a_0 represents absence of BCM activities. BCM activity variables are discussed in the chapter 2.2. In addition, IT service design cost variables were created to test cost effects by IT service designs, such as local vs. global service delivery requirements. This work is explained over the next chapters.

The dissertation is divided into seven chapters. After the first part, the introduction, the second chapter ‘Literature review' deals with the main drivers for BCM development in an organization. The structural components are discussed and foundational elements for independent variables are introduced. BCM and its function as part of IT service management set the context to the research. The discussion of IT resource, information security and BCM costs introduces the challenges of socio-technical cost classification and appraisal methods, while also presenting main components for the formation of the dependent variable. In the third chapter, the total cost of the BCM framework is conceptualized to provide a logical basis for the proposed BCM activity cost model and the articulated functional equations. Five hypotheses are presented to test the null hypothesis on the correlation between BCM activities and each cost category: all IT services, human resource, technology resource, organizational resource and IT service design costs.

Methodological choices are discussed in chapter four. Based on the argumentation of the positivist paradigm and the quantitative case research approaches, the chapter describes the research data collection and the handling of the 16 purposefully selected strata. The operationalization of the independent, dependent, control and selection variables are explained and the thorough coding process documented. The causal-comparative research design shows how BCM activity cost is measured by comparing two groups, IT services with and without BCM integration, by using the multiple linear regression analysis. Chapter five consists of the largest and the most complex portion of the dissertation. It first presents the evidence for passing the acceptance criterion for the use of multiple regression analysis. The results of the analysis are divided into five subchapters according to hypotheses. Each subchapter presents the main results from the hierarchical testing of three models – the changes between models show the cost effect of BCM activities. Particular consideration is paid to the full model (model 3), which includes the independent variables and the two control variables. The analysis of variance provides information on the statistical significance for each model, while the goodness of fit expresses the practical significance of the BCM activity costing. All of the above and guidance how to interpret results from the statistical testing and the model coefficients are discussed in the later part of the chapter with potential explanations for the observations. The main part of the dissertation ends with the conclusion that considers contributions, limitations and future research ideas.

2 Literature review

The literature review allows the researcher to gain a deep understanding of key concepts from the field of research by reflecting the earlier findings, establishing the justification for future research and outlining the theoretical foundation. Thus, it is an essential part of research (Jenkins, 1985; Levy & Ellis, 2006; Okoli & Schabram, 2010; Webster & Watson, 2002). In the first two subchapters, the reader is introduced to the relationship between BCM and crisis management, stemmed from the unreliability of early computing services, e.g., Hoong (2014), and how it later evolved to a standardized management practice, e.g., Herbane (2010). The third subchapter informs the reader about IT management frameworks and how BCM is merged into these models, e.g., Buckby (2010). The fourth subchapter reviews IS literature related to IT cost research, discussing direct and indirect cost factors and cost taxonomies. Though BCM can be considered as a distinct research topic in IS or a component of IT management frameworks (Gerke & Ridley, 2009), BCM has been a popular topic in information security research (Silic & Back, 2014). Because of the existing link between BCM and information security research (Buckby, 2010), the fifth subchapter discusses characteristics of information security cost factors. The sixth subchapter focuses on BCM literature and the cost of BCM research.

2.1 Business continuity management drivers

A crisis can be characterized as an unexpected, instantly escalating critical event that threatens the survivability of an organization – unless it is systematically controlled (Hermann, 1963; Pearson & Clair, 1998). In addition to naturally occurring disasters and societal disruptions (Guha-Sapir, 2017), the complexity of socio-technical systems can increase the risk of critical incidents in an organization (Bostrom, 1977; Cherns, 1987; Markus, 1983; Perrow, 1994). Perrow (1994) believed that it was only a matter of time for an inevitable crisis to occur in complex systems and while technologies have become more reliable since 1994, we can assume that some industries, like aviation, maritime and energy, are inherently exposed to higher risk of disasters and crisis if the human factor is part of this complexity (Weick et al., 2008). According to the Normal Accident Theory (NAT), complex interactive and closely coupled systems are inherently vulnerable to critical incidents (Hopkins, 1999; Perrow, 1994). The root cause of this stems from flaws in technology design (Bostrom, 1977) and the interaction between both technical and social systems (Cherns, 1987; Markus, 1983). Nunan (2017) suggested the application of the Normal Accident Theory to internet technology and big data systems because failure in these complex systems could seriously harm individuals and societies in a connected world. As the growing number of cyber incidents in recent years has shown (Anderson, 2019), interconnected socio-technical systems may be delaying an unavoidable crisis (Nunan, 2017). While the Normal Accident Theory may appear to be a reasonable driver for BCM, it may not apply in all conditions as incidents are not uncommon in modern organizations, but the escalation to crisis seems to be surprisingly rare (Hopkins, 1999). Paradoxically, this raises the question of how much of limited resources should be allocated to BCM considering that this capability is needed only when a rare event may occur.

The causes of incidents can be traced back to the latent failures of plans, decisions and designs of individuals or teams, rather than plain technical failures per se – hence, organizational performance plays the key role in reliable operations (Reason, 1990). In response to this challenge, High Reliability Organizations (HRO) pursue failure free culture by keeping safety and security as a core value and learning from prior failures (Roberts, 1990). Management of the workload variation, reduction of complexity in technology and collaboration beyond organizational boundaries (Roberts, 1990) as well as standardized routines (Feldman & Pentland, 2003) can increase the organizational reliability. It is assumed that BCM factors can have a positive impact on the company performance (Sawalha, 2013; Bakar, 2015). This idea may be supported as, according to Herbane (2004), the superior performance of a firm depends on the availability of resources, e.g., people, technology and supply chain. In addition to increasing reliability and performance goals, the ability to preserve business value by continuing business operations during disasters or crises would suggest that BCM can also be considered as a strategic activity for an organization (Herbane et al., 2004; Wong, 2009). In this context, BCM may reduce the negative impact of incidents on lead time, time-to-market and production throughputs – all of which are affecting an organization's reputation positively (Herbane et al., 2004).

In the 1950s, organizations took the first steps towards the digital age, and where information technology played a major role, computer professionals began backing up copies of critical data – a practice that emerged later to disaster recovery planning (DRP) (Hoong & Marthandan, 2014). DRP is a process the purpose of which is the development of a reactive plan to recover IT components and facilities from disaster (Hoong & Marthandan, 2014). Herbane (2010) traced the origin of business continuity management back to the 1970's disaster and contingency planning. This was the time when novel and unreliable information technology caused system crashes that could wipe or corrupt a major part (if not all) of critical data at once. Technology-focused disaster recovery plans were the main trend till the mid-1990s, but the pressure from regulators required a more complete perspective on disaster management in the form of business continuity planning (Herbane, 2010).

Since the late 1990s, protection of data and availability of IT services have been driven by regulators, fostering business continuity management to evolve towards standardized management practice (Herbane, 2010). The Foreign Corrupt Practices ACT 1977 (US) required organizations to protect records from destruction and as increasing numbers of records were stored in electronic format, this boosted the information technology industry to develop data backup and recovery solutions (Herbane, 2010). Furthermore, requirements for availably, business continuity and disaster recovery were encompassed in several regulations driven by legislators: Health Insurance Portability and Accountability Act 1996 (US), US Telecommunications Act 1996 (US), Gramm–Leach–Bliley Act of 1999 (US), Data Protection Act 1998 (UK), Personal Information Protection and Electronic Documents Act 2000 (Canada), Transmission of Personal Data Directive 2002 (EU) (Herbane, 2010). International standardizing organizations followed simultaneously, each issuing their own version of business continuity and disaster recovery best practice or incorporating recommendations into existing standards: IT Governance Institute Control Objectives for Business and IT, ISO/IEC 20000 IT service management, ISO 27001 Information Security Management Systems, ISO 27031 business continuity for information and communication technologies, ISO 24762 Guidelines for information and communications technology disaster recovery services 2010 (Herbane, 2010).

Reflecting on the above notes from the research literature, we can identify at least four key drivers for the development of BCM – the rare but critical consequences of disasters, the possible enhancement of organizational reliability and performance, the regulation that forced the protection of data and availability and the market’s expectation of higher quality through international standards. We can assume that the risk of crisis may drive senior management to invest in BCM, but due to uncertainties of likelihood and the impact severity, estimates of the cost and benefit can cause higher margin of errors. BCM may improve the organizational reliability and performance in some situations. However, the findings from literature did not support this assumption fully. It appears that regulatory enforcement of BCM applies to some industries, while others may be driven by market preference for organizations that meet international standards. Given these observations, there does not appear to be a single driver for BCM development, but rather many situational drivers that depend on the risk profile of the particular organization.

2.2 Business continuity management activities

Scholars in business continuity tend to make a distinction between business continuity (BC) and business continuity management (BCM). However, these seem to be closely related terms and distinctions may be difficult to make. Herbane (1997) defined business continuity as a "management process that identifies an organization's exposure to internal and external threats, and which synthesises hard and soft assets to provide effective prevention and recovery whilst enabling competitive advantage and value system integrity", implying that BC involves management activity inherently. Arduini (2010) defined business continuity as a "framework of disciplines, processes, and techniques aiming to provide continuous operation for essential business functions under all circumstances", suggesting that BC involves formal activities. Castillo (2005) defined business continuity as "an ability to retain a revenue stream through a crisis" while Bajgoric (2006) defined business continuity as an "ability of a business to continue with its operations even if some sort of disaster occurs". The International Organization for Standardization (2019) defines business continuity as a "capability of an organization to continue the delivery of products and services within acceptable time frames at predefined capacity during a disruption". The term 'capability' is as unclear as the term 'ability'. The purpose of BCM is to prepare organizations to reduce effects of disruptions caused by any of environmental conditions, technological failures, organizational shortcomings or human behaviour (Herbane, 2010; Herbane et al., 1997, 2004). Herbane (2010) concluded that business continuity management (BCM) had become a formalised structure and expression of an organization's crisis management values and practices with standards. Niemimaa (2015) considered BC as an integrative or holistic framework, while BCM could be considered as the planning and management model embedded into the organizational culture. Reflecting on the literature, it can be suggested that 1) BCM is driven by the business needs 2) BCM involves both social and technical perspectives 3) BCM is a cross organizational activity as well as 4) BCM produces embedded capability to resist and survive any type of incident. And while the deliverables or outputs of BCM include incident response and recovery plans, processes and tools, 5) BCM is intrinsically a proactive activity. Considering the above remarks, this research defines business continuity management (BCM) as follows:

Business continuity management (BCM) is a business-centric, socio-technical and cross-functional management activity to proactively establish an embedded capability to respond to anticipated incidents.

Research literature of BCM models discusses the pattern of interconnected routines observed among different types of organizations collectively (Table 1). It also seems to emulate the continuous improvement cycle Plan-Do-Check-Act (PDCA) model (Boehmer, 2009) as distinct BCM routines are often described as interacting cyclically (Baba, 2014). The level of enactment seems to vary depending on the complexity and type of industry, e.g., smaller organizations may apply BCM routines selectively, while larger and/or regulated organizations may incorporate all routines in a form of a program or managed by a dedicated department (Botha, 2004; Castillo, 2005; Cerullo, 2004; Gibb, 2006). This observation implies that theoretically, BCM can be considered as a specific application of an organizational routine (Becker, 2004, 2005). Following the ontology of organizational routines by (Feldman & Pentland, 2003), Table 1 aggregates the ostensive aspects of BCM routines reflected from the research literature. The description of the ostensive aspects of BCM routines is needed to provide a theoretical basis for the variable operationalization to measure the performance aspects of BCM routines in a case organization. While the term ‘routine(s)’ is used in organizational research, in this research the term ‘activity’ or ‘activities’ is used interchangeably, in order to link the definition ‘BCM routines’ with the Activity Based Costing theory (ABC) (Cooper & Kaplan, 1992).

Table 1 introduces the theoretical structure of BCM activities. The design is based on the observation of how the higher-level activities are defined using relatively similar terms, but the definitions of tasks within each activity vary among the research cases (Table 1). Intention is to inform the reader about the terminological challenges of determining BCM activities. Considering the suggestion of (Feldman & Pentland, 2003), this type of variation may be explained by differences between actors who may improvise the adoption of BCM situationally and by professional preferences. Because of differences between classifications, the framework suggests two abstraction classes – the activity class that defines ostensive aspects of BCM activities as well as the task class that defines performative aspects of BCM activities and incorporating a similar type of tasks within each activity class. The table is used for pattern matching and operationalization of the variables discussed in the chapter 4.5.

Table 1. Theoretical structure of BCM activity classes.

Activities (ostensive aspect)	Tasks (performative aspect)	Source
Establish the program	Top management support, objective setting, program initiation, project initiation, project planning, project proposal, project management, form framework and policies, organize the planning team, deploy governance, deploy scope, deploy investment	Hecht (2002), Pitt (2004), Botha (2004), Gibb (2006), Cha (2008), Harris (2008), Geelen-Baass (2008), Alonaizan (2009), Herbane (2010), Lindström (2010), Arduini (2010), Dey (2011), Randeree (2012), Aleksandrova (2018), Ueno (2018)
Understand the organization	Process analysis, resource analysis, event analysis, risk assessment, business impact analysis, business continuity plan requirements, environmental and system analysis	Hecht (2002), Pitt (2004), Cerullo (2004), Botha (2004), Castillo (2005), Gibb (2006), Geelen-Baass (2008), Cha (2008), Harris (2008), Herbane (2010), Lindström, Alonaizan (2009), Paton (2009), (2010), Arduini (2010), Dey (2011), Randeree (2012), Morisse (2017), Aleksandrova (2018), Ueno (2018), Turulja (2018)
Determine the business continuity strategy	Prioritize activities, define risk reduction/ mitigation strategies, determine business continuity strategies, design business continuity plans, define recovery resource requirements, define policies and procedures	Hecht (2002), Pitt (2004), Botha (2004), Castillo (2005), Gibb (2006), Geelen-Baass (2008), Cha (2008), Harris (2008), Herbane (2010), Lindström (2010), Dey (2011), Randeree (2012), Aleksandrova (2018), Ueno (2018), Turulja (2018)
Develop and implement the plan	Implement the strategy, develop the business continuity plan and the disaster recovery plan, plan for customer management, people relocation plans, develop business continuity centres, create maintenance plans, incident response plans, implement IT redundancies, link plans with change management, monitor and control plan implementation	Pitt (2004), Cerullo (2004), Botha (2004), Castillo (2005), Gibb (2006), Cha (2008), Harris (2008), Geelen-Baass (2008), Alonaizan (2009), Paton (2009), Herbane (2010), Lindström (2010), Arduini (2010), Dey (2011), Randeree (2012), Aleksandrova (2018), Ueno (2018), Turulja (2018)
Embed business continuity into organization	Business continuity plan training, education, awareness	Pitt (2004), Cerullo (2004), Botha (2004), Castillo (2005), Gibb (2006), Cha (2008), Harris (2008), Geelen-Baass (2008), Alonaizan (2009), Paton (2009), Herbane (2010), Lindström (2010), Arduini (2010), Dey (2011), Randeree (2012), Morisse (2017), Aleksandrova (2018), Ueno (2018)
Exercise, test and maintain the plan	Regular testing, simulation and plan exercises, maintain and update the plan, review plans and processes	Hecht (2002), Pitt (2004), Cerullo (2004), Botha (2004), Castillo (2005), Gibb (2006), Geelen-Baass (2008), Cha (2008), Harris (2008), Alonaizan (2009), Paton (2009), Herbane (2010), Lindström (2010), Arduini (2010), Dey (2011), Randeree (2012), Aleksandrova (2018), Ueno (2018), Turulja (2018)

As the first activity, research literature suggests the establishment of a BCM program to coordinate subsequent BCM activities in relation to resources and objectives given by the senior management (Arduini, 2010; Geelen-Baass & Johnstone, 2008; Herbane, 2010; Randeree et al., 2012). Organizations may have a dedicated function for BCM on a firm level (Toleman et al., 2009) or they can delegate activities, e.g., information systems continuity management to the IT department (Hecht 2002; Gibb 2006). Following codified standards, e.g., ISO publication of business continuity management system standard ISO 22301:2019, a program can introduce new practices and bring about change into the organization (Aleksandrova, 2018). Over time, a program can shift from schedule-driven activity into the organizational routines performed frequently by designated actors and functions (Butler & Gray, 2006; Feldman & Pentland, 2003). While this activity may be the catalyst for BCM development, it does rather facilitate other BCM activities than enhance the survivability of an organization directly (Boehmer, 2009). According to Boehmer (2009), the existence of business continuity management system (BCMS) does not itself predict the survivability of an organization, nor does measuring the level of implementation of controls such as business continuity plans and exercises. Considering the above and the program activity tasks, e.g., the forming of policies and frameworks, BCM program activities can be considered as meta-routines as opposed to routines (Adler, 1999; Feldman & Pentland, 2003). The distinction between meta-routines and routines has implications how the operationalization of independent variables has been done in this research – that is the formation of five BCM activity variables that reflects the performative aspects of organizational routines (Pentland & Feldman, 2005).

The second BCM activity is to understand the organization. When a disaster strikes, it is imperative to focus the response on the most valuable processes and resources in order to ensure business continuity (Cha et al., 2008; Herbane, 2010; Rabbani et al., 2016). Business impact analysis (BIA) is a task to identify critical business processes, resource dependencies and the impact if one of those resources were not available (Chow & On Ha, 2009; Wan, 2009). The result from BIA is used to determine the maximum acceptable outage that is the time that the organization can tolerate and the business recovery timeframe that is used to prioritize the allocation of key personnel, equipment and facilities for response and recovery (Pitt 2004). In addition to BIA, BCM professionals have to assess internal and external risk factors like environmental conditions, vulnerable technologies and complex organizational structures that could trigger a snowball effect leading to critical failure or exposure to external threats (Jordan, 2003). Business impact analysis and risk analysis (RA) can help the organization to define business continuity strategy for the optimal set of technical and non-technical controls to increase the probability of survivability in disasters (Geelen-Baass & Johnstone, 2008; Jordan, 2003; Randeree et al., 2012; S. H. Wan & Chan, 2008). While BIA and RA are frequently cited as the key tasks, there are additional tasks mentioned in research literature, e.g., environment and systems analysis (Morisse & Prigge, 2017) that can produce a different perspective for understanding business continuity needs. Regardless of which analysis has been used the decision how much an organization should invest in business continuity depends on the relevancy and accuracy of estimates provided to the management (Geelen-Baass & Johnstone, 2008; Karim, 2011).

The third BCM activity is to determine the business continuity strategy. Business continuity strategy outlines the intention of how to treat findings from business impact analysis and risk analysis (Cha et al., 2008). Strategies between organizations can vary based on the circumstances of each organization, e.g., financial organizations set baseline requirements for what is considered acceptable level of business continuity arrangement based on the regulation (Herbane, 2010). A privately owned manufacturing company may select a strategy based on its risk bearing capacity and transfer some portion of disaster risk to the insurance company and outsourcing partners instead of investing in internally hosted, robust and resilient IT systems (Paton, 2009; Rabbani et al., 2016). In a complex socio-technological environment, a strategy can be to build several layers of controls to protect a system's availability (Lumpp et al., 2008). A strategy can also be selective – Springer (2002) observed how internet service providers' business continuity strategy was to invest in technical solutions like systems redundancy and back-ups instead of alternative workarounds and processes. Springer (2002) argues that information-selling companies operate exclusively on technology platforms. Therefore, the survivability in disaster events relies on technical solutions (Springer, 2002). Furthermore, a strategy can pursue higher reliability by controlling the complexity of systems and reducing service integrations that may increase probability of interruption (Bajgoric, 2009). Alongside technology choices, business continuity strategy can consider restructuring organizational responsibilities, defining escalation paths and incident response procedures (Pitt 2004; Bairi 2012). Business continuity strategies may have limiting factors, e.g., implementing a resiliency strategy can be costly, as it takes a lot of effort to adapt to a particular environment (Morisse & Prigge, 2017). According to (Post & Diltz, 1986), the identification of the most cost-effective strategy may require simulation of how alternative strategies would impact the recovery time in disaster (Post & Diltz, 1986). Reflecting on the literature, this activity can be concluded when the final strategy has been defined and supported by the senior management.

The fourth BCM activity is to develop and implement the plan. Business continuity plans (BCP) have evolved from responsive technical disaster recovery plans (DRP) to comprehensive plans that incorporate crisis management principles in socio-technical context (Pitt 2004). Business continuity plans converge complex business interruption scenarios, whereas disaster recovery plan focuses on specific functions or systems (Herbane et al., 1997). Plans can be designed for both business and technical dimensions, implemented in relevant departments based on the nature of anticipated failure, e.g., technology vs. societal viewpoint (Botha, 2004; Geelen-Baass & Johnstone, 2008; Herbane et al., 2004). Business continuity plans are not only limited to response and recovery but can encompass a range of activities to be taken proactively to reduce the risk of failures and prepare for faster business restoration back to normal (Norrman & Jansson, 2004). Complex plans can comprise cross-dependencies between key business processes and information systems to secure end-to-end continuity of business (Wan & Chan, 2008). Such an implementation can be built in an ‘onion’ model, where each layer provides resilience against different type of incidents, e.g., off-site storages against site level threats, LAN/WAN based back-ups for data loss, virtual servers for single server loss, automatic failover for server operating system incidents and fault-tolerance hardware for component broke-ups (Bajgoric, 2009). According to Pentland & Feldman (2005), organizational routines are manifested in the form of artefacts that can change the behavior of an organization or the desired state of the environment. This manifestation can be observed when the BCM strategy is transformed into socio-technical artefacts like service agreements, incident response teams, crisis communication plans, as well as to physical and digital installations such as backup data centers and mirrored databases (Pitt 2004; Paton 2009; Randeree 2012). A closer look at literature suggests that performative aspects or tasks of this BCM activity are completed once the abstract BCM strategy is transferred into concrete, tangible or intangible, execution objectives.

The fifth activity goal is to integrate business continuity in the organization. According to Rapaport (2008), organizational survivability is an outcome of the social adaptive process. While plans and drills are essential instruments to prepare employees and managers for disaster situations, it is more important to influence adaptive behavior that is rooted from past experiences, community attitude and social networks at the workplace (Geelen-Baass & Johnstone, 2008; Järveläinen, 2013; Paton, 2009; Rapaport & Kirschenbaum, 2008). Embedding business continuity into the organizational culture and routines by frequent training and awareness campaigns can change adaptive behavior in a way that an organization becomes more responsive to disruptions and even disasters (Cha et al., 2008; Herbane et al., 2004). This may not be sufficient, as Rapaport (2008) highlights: Employees would likely perform better in an emergency if they considered their workplace to be safe and if they were invited to participate in the decision-making processes. This suggests that involving employees in, e.g., BCP evaluation, may be one of the most important tasks to ensure effective business continuity implementation.

The sixth and the last activity class consists of three key tasks – exercising, testing and maintaining the plan. Taking into account previous notes from literature, business continuity management can be a complex and expensive activity as it may involve a range of tasks, from integrating recovery capability into hardware, software, data and network to determining the workflows for how IT service can be recovered in a controlled manner (Hoong & Marthandan, 2014). When any element of an information system has changes, e.g., software version, network address or authentication system, the whole recovery capability becomes unreliable (Hoong & Marthandan, 2014). Since information systems and information itself are inherently subject to change, new business requirements, technology and data changes need to be considered in maintenance tasks to ensure the availability and integrity of the systems (Karim, 2011; Winkler et al., 2010). Regular practice of plans increases confidence that what is in the plan can be performed by staff (Geelen-Baass & Johnstone, 2008; Randeree et al., 2012). Tests and simulated failures can improve an organization's routine-like-capability to react to critical incidents and reveal potential shortcomings in plans caused by missing information at initial creation or changes in systems and data (Pitt 2004; Butler 2006; Cha 2008; Paton 2009). The importance of this BCM activity is critical to maintain the survivability of an organization, as the ability of American Express and Merrill Lynch to return to business within hours after the WTC attack demonstrated (Hecht, 2002). According to ISO 22301:2019, Business continuity management systems, BCM maintenance considers activities to ensure that any changes that impact the organization are reviewed in relation to BCM. Changes can be organizational e.g. merger or restructuring or system changes due to new products and systems. Such changes may require changes also in BCM solutions, processes and documentations to ensure suitability, adequacy and effectiveness of BCM (International Organization for Standardization, 2019).

Depending on the context and the researcher's preference, business continuity management research may take different perspectives, e.g., strategy (Herbane et al., 2004), information systems (Turulja & Bajgoric, 2018), or information security (Silic, 2014). In this research, the focus is on information systems continuity e.g., Järveläinen (2013). Considering the variety of perspectives, information systems continuity research can be considered as an interdisciplinary research domain that may involve any combination of social processes, technology constructs, management models and their interrelations (Rapaport & Kirschenbaum, 2008; Herbane, 2010; Bajgoric, 2010; Turulja & Bajgoric, 2018). Niemimaa (2015) identified four information systems continuity research perspectives: 1) social aspects as IS continuity enabler, 2) technology as IS continuity enabler, 3) salience of IS continuity, and 4) models that improve IS continuity. The perspective in this research is the activities of information systems continuity management in the context of IT service management. While information systems continuity management takes a more holistic viewpoint on technology, people and processes (Järveläinen, 2013), IT service continuity management can be considered as a subset of information systems continuity management research focusing on questions related to IT service management (Tan 2009; Johnson 2007; Cater-Steel 2006). Alongside other IT service management processes, the ITIL framework integrates business continuity management into IT service management (OGC, 2002, 2007) defining it as *a process to manage an organization's capability to provide the necessary level of service following an interruption of service or a major disaster* (OGC, 2002, 2007). The objective of IT service continuity management is to guarantee a pre-determined minimum level of IT service based on the business impact analysis (Wan, 2008), and if a critical incident occurred, the goal would be to reduce the impact on service quality expectations of customers (Hoong & Marthandan, 2014).The adoption of IT service continuity management appears to be relatively prevalent in organizations, in relation to other tactical level IT service management processes (Marrone et al., 2014). Hence, it is important to understand key concepts of IT service management.

2.3 IT service management processes, resources and designs

IT service management (ITSM) is a commonly recognized framework to integrate people, processes and technologies end-to-end in a cost-effective manner (Cater-Steel et al., 2006; Conger et al., 2008; Winniford et al., 2009). For technology companies like Amazon, Google, Facebook and both aviation and finance, among many other industries, IT services are an essential part of modern business operations (McKinty, 2006). Service systems are interconnected information networks, composed of configurations of interacting people, technology and organizations. Alter (2006, 2008, 2014) argued that the elemental unit of a modern service system was an information technology work system where people, together with information technology and needed resources, produce outputs in the form of a service or a product. A process is considered a set of activities taken by people (participants) towards a common goal (Conger, 2008; Johnson, 2007), and operating as an interface between the organization and systems (Alter, 2013). In the context of IT service management, generally acknowledged processes reflect focused managerial activities to fulfil IT service goals such as: availability, capacity, finance, continuity, configurations, changes, releases, incidents and problems, just to mention a few (Johnson, 2007).

The technological evolution of enterprise-wide applications, such as e-mail, internet, enterprise resource planning, fostered IT organizations to develop customer-oriented management models to support business processes in a coherent manner (Lepmets, 2012; Wan, 2008; Winniford, 2009). This synthesis between business and information technology perspectives started to increase value to both internal and external customers (McNaughton et al., 2010; Proehl et al., 2013; Winniford et al., 2009). As the semantics of IT service management evolved from the necessity to communicate complex technology needs between IT and business organizations (Conger et al., 2008; Valiente, 2011; Winniford et al., 2009), technical terminology was replaced by higher abstractions, such as processes and services (Conger, 2008; Johnson, 2007).

The origin of IT service management can be traced back to IT quality management research by IBM in 1972 (Cater-Steel, 2009). The kickstart was the improvement program for IT efficiency by the Office of General Commerce (1989) in the UK, later coordinated by the IT Service Management Forum, a non-profit association (Cater-Steel, 2009). Since that time, the international collaboration to collect best practices, known as Information Technology Infrastructure Library or ITIL for short, has become one of the key IT management frameworks (McNaughton et al., 2010). The foundation of IT service management is not only ITIL-based but is equally impacted by the US originating management concept, Service Level Management (SLM), that unifies the best IT management practices acknowledged by different industries under SLM umbrella (Conger et al., 2008).

The widespread adoption of IT service management can be explained by the coercive pressure from customers and governances, the normative pressure from the IT service management industry offerings and organizations' motivation to benchmark success against industry best practices (Cater-Steel et al., 2009). Alongside IT service management approaches centered ITIL and SLM, IT governance (De Haes & Van Grembergen, 2005; Weill & Ross, 2004) and COBIT (Mangalaraj et al., 2014; Ridley et al., 2004) are broadly renowned IT management frameworks across different industries internationally, especially within large organizations. Despite the general acceptance of IT service management among organizations, it appears that IT management frameworks are not consistently used by all IT practitioners (Conger et al., 2008; Winniford et al., 2009). A possible explanation for this may be the overlapping IT management frameworks (Conger, 2008; Winniford, 2009.) From the IS research perspective, this observation can suggests that the theoretical foundation of IT service management is dispersed, and no dominant theory or model can be validated in the IT service management research field (Proehl et al., 2013; Shahsavarani & Ji, 2014). Prior research indicates that ITIL-based IT service management concepts are extensively used, especially within larger organizations. However, the homogeneous implementation across all IT organizations is not evidenced (Marrone et al., 2014).

Marrone (2014) proposed three explanations for the variability of IT service management implementation. The first explanation assumes that tactical and strategic processes require coordination, cooperation, and consensus between organizational units, while operational processes are performed by cohesive workgroups within a single organizational unit. Therefore, the IT department requires less interaction and approval from other organizational units (Marrone et al., 2014). The second explanation is based on the assumption that IT service management processes are adopted by using a framework other than ITIL e.g., COBIT or a combination of several frameworks (Sahibudin et al., 2008). The third explanation is related to different versions of ITIL and the maturity level of the organizations. In other words, operational processes are adopted first when an organization matures; tactical processes are adopted later (Marrone et al., 2014). IT service management processes can generally be divided into two main categories as described in Table 2 to make a distinction between characteristics of different activities.

Table 2. IT service management activities and processes.

Activity categories	Processes	Sources
Operational level	Configuration management, Change management, Release management, Incident management, Problem management, Service-desk	Johnson (2007), Cater-steel (2006)
Tactical level	Service level management, Availability management, Capacity management, Financial management, IT service continuity	Johnson (2007), Cater-steel (2006)

When reading the IS literature, one cannot avoid noticing how the term *resource* is frequently used in the context of processes and activities, and while IT service management activities can be expressed particularly in standards like ITIL (Cater-Steel et al., 2009). The distinct definition of the resource can vary depending on the scope of IT and IS research (Wade & Hulland, 2004). In relation to research on the resource-based view, Wade and Hulland (2004) suggested defining resources as a combination of system-based capabilities and technology-based IS assets, whereas capabilities can be defined as processes or repeatable patterns of activities. Considering the above definition, the term capability appears to reflect the organizational routine definition (Feldman, 2003; Becker, 2005). Because of this similarity in definitions, we might assume that capabilities facilitate organizational change and stability similar fashion as routines. However, the relation between capabilities and routines may not be evidenced. In contrast to routines, capabilities can be discussed as a higher level of abstraction that describes a firm’s ability to use routines in the most productive manner (Abell, 2008). Therefore, Abell (2008) suggested that resources were micro-foundations for capabilities, implying that capabilities were the sum of routines (Abell, 2008). According to Wagner (2006), capabilities are based on organizational processes that emerge from routines and relate to regular and predictable patterns of activity. In this model, resources are inputs to the processes that transform assets into higher value outputs and thus generating value for an organization (Wade & Hulland, 2004; Wagner, 2006). Following Wagner's (2006) perspective, the term 'capability' is excluded from this research, as the scope of IT service management adopts a more routine-based rather than capability-based perspective. In addition, forthcoming chapters shall consider the terms 'activities', 'processes' and 'routines' as synonyms and is distinct from the term 'resources', which is discussed in the next chapter.

Ross (1996) suggested dividing information systems assets into three IT asset categories: 1) human assets, 2) technology assets and 3) relationship assets. Human assets focus primarily on the inherent capacity of individuals and groups, which include the availability of up-to-date IT technical skills and the ability to deploy, use and manage that knowledge in an organization, to the extent that they are transferable (Ross et al., 1996; Bharadwaj, 2000). While technical skills like cyber security and data science are highly important hard skills, soft skills like business understanding, critical and strategic thinking are equally valued by IT organizations (Kappelman, 2020). On a general level, the technical assets category involves system elements like hardware devices, system and business software, databases as well as technical standards for communication and infrastructure architecture (Ross et al., 1996; Bharadwaj, 2000). Over time, specific and innovative technical assets like Big Data, Cloud Computing and AI/Machine Learning can gain attraction in organizations and thus broaden the overall IT technology asset pool (Kappelman, 2020). Relationship assets consider interaction between IT and internal stakeholders, external suppliers and partners – in other words interaction between different internal and external organizations. The ability to manage development and outsourcing partners to build relevant solutions and maintain these information systems in a cost-effective manner can become an important organizational resource and may increase competitive advantage for a company (Ross et al., 1996; Bharadwaj, 2000). The purpose of Table 3 is to present how different asset types can be classified under each top-level category as suggested by Ross (1996), and as such do not attempt to provide a comprehensive list of all assets.

Table 3. Asset-based IT resources.

Resource categories	Resource types	Sources
Human	Technology skills, business understanding, problem-solving orientation, critical thinking	Ross (1996), Bharadwaj (2000), Kappelman (2020)
Technology	Physical IT assets, technical platforms, databases, architectures, IT infrastructure, software, hardware, Cloud Computing, Enterprise Resource Management	Ross (1996), Bharadwaj (2000), Kappelman (2020)
Relationships	Partnerships with other divisions, client relationships, top management sponsorship, development partnerships, vendor and supplier management	Ross (1996), Bharadwaj (2000), Kappelman (2020)

IT service management incorporates processes and assets like people, technologies and organizations under an umbrella, where every activity and resource must work together in a timely, reliable and cost-effective manner to create value for an organization (Wagner, 2006; Orta, 2014). Customers, both internal and external, assume that IT services are delivered on agreed performance levels within the service cost rate accepted by the customer organization (Abrahao 2006; Cater-Steel 2006; Johnson 2007; Conger 2008; Winniford 2009). In order to manage expectations between IT and the customer organization, anticipated IT service levels are often expressed in descriptive forms, e.g., platinum, gold and silver in service level agreement (Abrahao, 2006; Conger et al., 2008; Galup et al., 2009). Descriptive service levels may simplify communication between customer organization and IT but may not be specific enough to drive both design and operation in IT (Moura et al., 2006). Because of this, service levels can be defined as executable and quantified service level objectives (SLOs), measured at the information system level, such as response time, availability and throughput – all accounted already in IT service design phase (Moura et al., 2006).

According to Mora (2014), IT service design is an intellectual activity to transform a set of system requirements in a set of system specifications which satisfy a set of agreed goals and constraints, e.g. from SLA management, and at the same time enable the development and building of the designed system. Goals are anticipated properties for system users, like performance and user experience, while constraints are limits related to the consumption of resources used for designing, building and operating the system (Mora et al., 2014, 2015). Designing an IT service requires contemplation of interactions of several human and technology components: hardware, software, databases, networks, data, applications, environment and internal as well as external teams (Mora et al., 2014, 2015), not to mention contractual and other legal ramifications often expressed in service level agreements (Smith, 1995; Goo & Huang, 2008; Moura et al., 2006). Although IT leaders pursue to change the mindset of IT organizations from technology towards service and despite empathy, availability and reliability being essential parts of IT service quality (Lepmets, 2012), the correlation between system issues and customer satisfaction (Choi & Yoo, 2009) supports the assumption that the information technology perspective is the dominant theme in IT service design (Kappelman et al., 2020).

Considering the identification of key differentiators of IT service designs may be challenging. While enterprise systems can be grouped into different clusters (Nevo, 2010), classified by the collective use of systems (Negoita, 2018) or by the problem the system solves (Forward & Lethbridge, 2008), the overall diversity remains overwhelming. In order to resolve issues on system and software classification, Forward and Lethbridge (2008) suggested the following four groups: 1) data-dominant software like business- oriented software, e.g., data warehouse, CAD/CAE tools, strategic and operations analysis and programming tools; 2) systems software, e.g., access management, operating systems, anti-virus, firmware, middleware, networking/ communication; 3) control-dominant software, e.g., hardware-control, firmware, device control and 4) computation-dominant software, e.g., simulations, big data search, scientific software and AI (Forward & Lethbridge, 2008).

This type of fixed classification can help researchers to establish criteria to compare different IT services. However, frequent changes in business environments foster IT departments to consider systems adjustability on demand (Lepmets, 2012). Customization can be viewed as a specialization of a business asset and business strategy (Haines, 2009). In comparison to standard software or system offering, customizing functionalities to the specific user groups within or outside of the organization can improve user acceptance and satisfaction (Cox et al., 2012). Disconnecting unnecessary software functionalities can save system resources and improve performance, especially resource-constraint systems like embedded systems (Irani et al., 2006). Although change management for custom software and systems can be resource consuming and costly, it can improve information exchange between organizations and thus create value on supply chain management and partnering. It can even lead to an overall better organizational performance (Cox et al., 2012). In comparison with in-house proprietary software development, commercial software and enterprise system customization can involve technical constraints as well as intellectual property issues that may limit the use of technology or modification of software (Chen, 2017). We can assume that customization of any system in IT service can be a complex activity with potentially critical implications for the overall performance of an organization in case of failure. Hence, it is imperative that these customizations of systems are managed carefully, especially since the supplier's involvement can play an important role in this activity (Haines, 2009). Consequently, all these designs can affect costs by directing how information systems are meant to perform and how IT organizations allocate resources to maintain IT systems and respond to incidents (Moura et al., 2006). As an example, the observation by Soufi et al. (2019) implies that higher recovery objectives, defined in SLAs, can cause an increase in costs as organizations allocate resources to protect and preserve the value of an organization

Thinking back to Kappelman (2020) and his annual study of IT spending, which has averaged 4.5% of revenue over the past 11 years, with budgets increasing year on year, it is understandable why the top 10 IT management performance metrics include four financial metrics: cost reduction, budget compliance, IT spending and IT value to the business. Since service level agreements control the use of IT organizational resources and thus the overall financial performance, monitoring is an important part of IT management work. We can assume that identifying the cost drivers of IT resources is essential to get control over spending (Irani, 2000, 2001. 2006; Love, 2006).

2.4 Cost of IT resources

According to Ross (1996), the impact of IT on the competitive advantage or superior performance is fundamentally based on the idea of the heterogeneity of valuable resources, meaning that a resource is of value if it improves a company's cost position by reducing costs and/or if it increases the revenues. The cost of computer assets and IT staff (Brynjolfsson & Yang, 1996), the management of IT development and operations (Winniford et al., 2009) and constant technology transformation (Kappelman et al., 2018; Venkatraman, 1994) can be significant sources of organizational costs. In this setting, ineffective cost recognition can increase the risk of double counting of same cost factors, omission of costs, hidden costs and spill-overs (King, 1978; Neuman, 2004; Peacock, 2005). Therefore, understanding the life cycle-cost, from the IT system design to the termination of an IT service, is essential for the total cost of IT ownership optimization (Fildes, 1992; Ghoneim & Irani, 2003; Woodward, 1997). Organizations should define reliable methods (Sassone, 1988) to recognize cost-factors associated with all aspects of IT (Orta, 2014); the core reasoning here is based on the assumption that the precise identification of costs is foundational for overall information systems, financial management, budgeting and investments (Irani et al., 2006; Love et al., 2006). There are numerous IT investment and cost calculation techniques, like Return of Investment, Total Cost of Ownership and Activity Based Costing (ABC), each of them used to explore the best return and business benefits when investing and budgeting in IT (Moura et al., 2006). Well-defined cost factors are valuable components for several techniques like ABC and TCO (Irani et al., 2006; Moura et al., 2006).

There have been several attempts to create an all-encompassing IT cost taxonomy to capture the sources of costs, but as Irani (2006) argued, capturing all underlying IT cost factors on a practical level may not be a simple task in information systems and IT service context. This challenge is caused by the inherent complexity of socio-technical systems, organizations’ unique system implementations and the constant development of technology (Irani et al., 2006; Love et al., 2006). Because of the diverse system and service landscape, Irani (2006) concluded that while each taxonomy offered a slightly different view of cost classification, in absolute terms, none was better than the other but served the purpose of different goals. In order to make sense of cost classifications, Table 4 attempts to summarize and show the diversity of cost types as they were defined by different authors. When interchangeable or synonymous terminology was used, the most often used expressions have been added to the list. This is not an excessive representation of all classification models but an alternative perspective on how to classify IT costs and as such, it does not offer a conclusive model but only a suggestive one. It is also important to stress that the selection of publications was based on convenient sampling, in relation to seminal research work by Irani, Love and Ghoneim over the years.

Table 4. Example of IT cost classification approaches.

Cost types	Kappelman, 2020	Oesterreich, 2017	Anderson, 2013	Tiong, 2009	Bruijin, 2008	Gordon, 2006	Irani, 2006	Love, 2006	Ardaga, 2005	Ghoneim, 2003	Gerlach, 2002	Ezingeard 1999	Heikkilä 1995	King,1978	Woodward,1997
Initial costs	x	x	x		x		x		x	x				x	x
Policy & planning costs					x										
HW purchase costs		x	x		x		x				x	x		x	x
SW purchase costs	x	x	x		x		x				x	x	x	x	x
Customization costs		x					x							x	
Installation costs		x							x					x	x
Consulting costs		x			x							x		x	
Infrastructure costs		x					x				x			x	
Ongoing costs	x	x	x		x					x				x	
HW maintenance costs		x		x	x		x		x		x			x	
SW maintenance costs	x	x		x	x		x		x		x		x	x	
Support costs		x		x	x		x		x				x	x	
Change costs		x		x	x		x						x	x	
Lease costs		x	x	x	x		x		x					x	
Test costs					x							x			
Auditing cost					x										
Insurance costs							x								
Decommissioning costs															x
Personnel costs		x	x		x	x					x				
Cost of training	x	x			x	x	x					x	x	x	x
Cost of procurement		x												x	x
Cost of start-up activities		x			x		x							x	
Cost of administration and operation activities		x			x	x	x		x	x		x		x	x
Cost of application development		x											x	x	
Project management costs						x	x							x	
Changes in salaries		x				x	x							x	
Organizational costs		x				x				x					
Costs of business process restructuring		x				x									
Costs for change management		x													
Disruption of productivity costs		x				x								x	
IT capital investment costs	x									x			x	x	x
Outsourcing costs	x					x									
IT R&D costs	x									x			x	x	
Offshore IT costs	x					x									
Security costs	x		x		x		x								

As the above table informs, IT costs can be classified in several ways, depending on the context. As an example, IT costs can be divided into initial and ongoing costs based on the information system lifecycle and resource types, e.g., Ghoneim (2003). Initial costs emerge from information system design and implementation activities, incorporating cost of work and acquiring technology (King & Schrems, 1978). Since initial costs are only considered in the early phase of an information system's lifecycle, they can account for a relatively small share of IT lifecycle costs (Irani et al., 2006). Ongoing costs refer to all activities and resources consumed for maintaining the information system until the point of sunset; that is the point after which the system is considered obsolete in relation to the organizational needs, e.g., Oesterreich (2017). Ongoing costs are generally fixed costs that arise from the effort required to maintain the system and payments for technology and supporting services (Irani et al., 2006). Since information systems are subject to internal and external change factors, such as business process changes and functional updates, part of the ongoing costs involves variable costs, the extent of which is influenced by the scope and complexity of the change (Irani et al., 2006).

The breakdown of costs into initial and ongoing costs provides insight into how costs are distributed in different phases of the information system lifecycle. This perspective, however, provides only a limited view (Ghoneim & Irani, 2003; Irani et al., 2006; Love et al., 2006) as it may not be possible to distinguish how costs are allocated between processes, people and technology. As the work system theory (Alter, 2006, 2008, 2014) suggests, we can assume that costs arise, for example, from software maintenance activities that involve work efforts from people who are using tools and solving issues according to processes. Cost factors that can be attributed to the implementation and operation of a distinct information system can be classified as direct costs (Irani et al., 2006). Following this logic, we can accept the idea that if resources like people, technology and processes are designated solely to a single information system, the causation between information system performance and cost is direct. This logic may be true, but it is not realistic, because organizations rely on more than one single information system, such as planning, communication, and infrastructure management systems. Furthermore, due to financial targets, IT organizations are progressively increasing the utilization of shared resources, cloud computing, centralized IT governance activities and processes for the purpose of reducing organizational costs in IT (Kappelman et al., 2018). Thus, it can be assumed that some portions of the costs are indirectly caused by shared resources and common processes. Whereas the direct costs are assigned to the technology components of an IT service, the indirect costs are related to the organization and the activities (Love et al., 2003, 2006).

IT governance frameworks like ITIL-based IT service management allow optimization of time to spend on IT management activities and in the longer run, well-established frameworks may improve overall effectiveness (Tiong et al., 2009). Paradoxically, when an IT organization implements overarching IT service management processes and centralizes its operations, the ability to observe direct costs becomes challenging and an understanding of indirect costs becomes even more important in business planning (Love et al., 2006). Indirect costs can be traced back to people and time used for planning, coordination and monitoring of activities across multiple information systems and services (Love et al., 2006). According to Love (2006), a significant amount of time is used for evaluations and investigations to improve information systems' performance. In addition to development activities, specific support activities, such as incident and problem management, account for a considerable share of indirect costs (Love et al., 2006). Changing technology and new user requirements foster IT organizations to continuously maintain their change management capacity, stemming from the need for cutting-edge expertise, either through training or hiring (Love et al., 2006). While IT management frameworks may improve operational effectiveness (Tiong et al., 2009), hidden or indirect costs hinder the measurement of cost efficiency of IT organizations and can therefore further limit optimized performance. This is not a trivial question for any organization as indirect costs are suggested to be higher than direct costs – in fact, even four times higher (Love et al., 2006). IT costs, both direct and indirect, affect the overall organizational performance. Consequently, from a theoretical perspective, cost factors can help measure net benefits and contribute to the success of information systems (DeLone & McLean, 1992, 2003, 2016).

The most important observation from IT cost literature is the challenging nature of how to determine and measure indirect costs. The examination of the various classification approaches suggests that initial and ongoing costs can include both direct and indirect costs on information systems (Table 4). In addition to the distinct system-specific direct costs, such as purchasing cost, direct cost taxonomy can include activity-based factors like customization, maintenance, support and change costs, where each activity can have indirect cost characteristics. As an example, change costs refer to change management work that combines human efforts, tools and processes on how the change is executed. All the above leads to the conclusion that IT costs consist of cost factors that can be classified as direct costs or indirect costs, depending on the agreement within the organization and the researchers' scope while determining cost categories.

In response to traditional limitations in cost management, such as the confusion between direct and indirect costs, Cooper and Kaplan (1988) introduced the Activity-Based Costing (ABC) model for indirect costs accounting. In the ABC model, indirect (overhead) costs like management activities are assigned to the cost objects, such as products, organizations and customers (Cooper & Kaplan, 1988). The ABC theory is based on the premise of the cause-and-effect relationship between cost objects, activities and resources (Wegmann & Nozile, 2008). According to the theory, demand from the customer to the cost object, e.g., a service, triggers activities that consume resources (Cooper & Kaplan, 1988). The cost of the resources consumed is attributed to the activities and measured by the *cost drivers*. Besides, the costs assigned to the activities are traced back to the cost objects and measured by intensity and quantity of *activity drivers* (Cooper, 1998; Cooper & Kaplan, 1988, 1992).

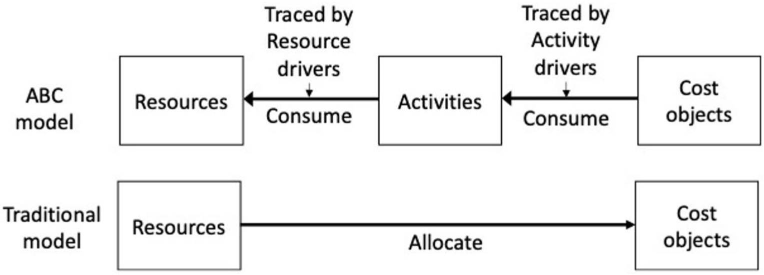

Figure 2. Illustration of difference between ABC and traditional cost accounting causation.

The ABC model has been criticized as 'complex' and 'costly' for practical management accounting (Wegmann & Nozile, 2008). Because of this, since the publication of the original model, several ABC applications have been introduced to solve specific issues in cost accounting, e.g., Customer Profitability Analysis, Interorganizational Cost Management, Resource Consumption Accounting, ABC and Life Cycle Costing and Time-driven ABC – just to mention a few of the applications (Wegmann & Nozile, 2008). Despite challenges in the use of ABC, it can help organizations to uncover hidden sources of profitability and costs (Turney, 2010) and it can be widely used in different contexts: for product pricing, identification of value-added activities, outsourcing decisions and for total quality management in manufacturing and service industries (Ooi et al., 1998).

Škoda (2009) argued that ABC was an economic model that was not limited only to past financial information and thus could not be referred only as an accounting model. According to Škoda (2009), besides historical data input, simulation data can be entered in ABC to predict the activity expenses and activity driver information to obtain estimated spending for future activities and resources. Forecasted activity expenses can be used as a target costing mechanism and budget information is helpful to eliminate inefficient, non-value adding activities from operations (Škoda 2009). The ABC model can indicate whether past patterns will persist in current or future periods based on current and projected information (Škoda 2009).

ABC can offer an alternative and practical way to track overhead costs in process-oriented organizations (Schiffauerova & Thomson, 2006; Tsai, 1998) and help them to have balanced understanding of efficiency and effectiveness for costs associated with IT services (Gibb et al., 2006). Neuman et al. (2004) developed an ABC-based management tool to measure productivity in IT divisions, in order to plan IT cost chargebacks and improve processes. The findings suggested that the use of the Activity-Based Costing (ABC) model aided the organization to identify unused capacity, optimize value-added and non-value-added activities in IT and have more accurate cost estimates for IT projects (Neuman et al., 2004).

According to Gerlach et al. (2002), the most effective chargeback methods are based on rational cost analysis methods, such as ABC. Gerlach et al. (2002) argued that measuring IT service delivery by the Activity-based Costing model could help the IT management to communicate the justification of IT cost with business management, strategically optimize resource utilization and provide data to stimulate change. ABC can contribute to the investment decisions for new technologies by measuring the impact of investments on profitability through operating costs (Peacock & Tanniru, 2005). Incremental implementation of new technology can be measured bottom-line by using ABC tactics in analysis to understand how different units consume investments. Peacock and Tanniru (2005) suggested that the ABC model might be most effective for measuring IT investments when technology architecture was spread across business activities and business activities were distributed across products.

Following the above reasoning of ABC benefits in IT and acknowledging the challenge of how to measure indirect costs (Ghoneim & El-Haddadeh, 2006; Love et al., 2006), it appears that ABC can disclose how IT activities affect business performance (Maiga, 2015), which helps the IT organization to align operations and improve the strategic dialogue between IT and business (Dedene et al., 2008). Furthermore, ABC can help identify costly processes related to information systems management and provide better justification for budgets and investments in IT (Adeoti, 2012; Ooi et al., 1998; Roztocki & Weistroffer, 2009).

2.5 Cost of information security

According to Bruijn (2008), BCM is a distinct security activity to be encompassed in the cost-benefit analysis along with identity management, access management, intrusion detection systems and data loss prevention. Considering the intersections between BCM and information security research, we can assume that the inclusion of the information security economics research perspective can contribute to determining the cost of BCM (Silic & Back, 2014).

Information security economics discusses innovations as well as consumer choices and the security role in marketing, but the majority (75.7%) of research projects examine decisions how to reach optimal security investment in an organization (Silic & Back, 2014). According to Silic, (2014), out of all information security publications, information security publications dealing with economics add up to 2.6%, implying that this topic cannot be considered mainstream research. However, the growing trend from 1997 till 2012 suggests that the topic is getting attention among researchers and decision makers (Brecht, 2013). In addition, self-organized research communities such as the Workshop on the Economics of Information Security (WEIS) discuss disciplines from the fields of economics, management, law and computer science and thus actively promote academic research on information security economics.

The key paradigm in the economics of information security follows the logic that security spending should not exceed the point of marginal benefit. To be more precise, costs should not be higher than the anticipated loss to the organization if the security risk materializes (Gordon & Loeb, 2002). Ironically, in order to benefit from security investments, an organization should avoid or mitigate security incidents. This leads to the conclusion that if nothing has happened to the organization, it is reasonable to assume that the investment has paid for itself or, in other words, the revenue from the investment for additional security improvements has proven to be the optimal strategy (Gordon & Loeb, 2006). The loss-based rationale for investments can be challenging because of a substantial number of failure scenarios as well as combinations of chains of events that can lead to material security incidents (Anderson, 2013). As an alternative to loss-based estimations, one can compare the cost of security measures between other organizations (Butler, 2002). The approach may have limitations due to contextual designs and implementations of information systems between organizations (Brecht, 2013; Butler, 2002). It was suggested to integrate the cost-benefit method into information security budget planning to reduce the risk of inaccuracy caused by isolated cost and loss calculations (Butler, 2002; Gordon, 2006).

Cost-benefit models appear to resolve concerns regarding inaccuracy in information security budgeting. However, Olifer (2017) argues that the determination of cost factors is a prerequisite and fundamental component for any economic appraisal model. Because of the suggested dependency on cost components, it is reasonable to assume that ambiguous cost factor definitions could cause accumulated errors on overall cost-benefit estimates. This assumption underlines the importance of explicit definitions. The security cost taxonomy model, suggested by Anderson (2013; 2019), classifies security costs into two main categories, losses and costs, and four distinct classes: direct and indirect losses, defense costs and costs to society (figure 3). In the model, direct losses have a material impact on an organization caused by criminal activities, e.g., lost money and recovery costs, while indirect losses are delayed impacts, usually manifested in the form of lost opportunities and future revenues (Anderson, 2013, 2019). The defense cost category provided by Anderson (2013; 2019) does not make a distinction between direct and indirect cost factors but comprises all cost factors without further categorization. Defense costs can be used to measure prevention efforts, including security systems like antivirus, network and access control measures as well as activities like security management (McLaughlin & Gogan, 2018). Besides, defense costs seem to have certain characteristics as specified by the IT costs taxonomy (Table 4), involving direct costs of security measures that can be classified as one-off and recurring costs (Gordon & Loeb, 2006) as well as personnel costs associated with activities like security monitoring and incident response. Considering the all-embracing perspective, indirect losses and defense costs can be very substantial, even ten times more than other cost types. Furthermore, Anderson et al. (2019) suggests that costs emerging from supporting infrastructure together with defense costs, continue to be the dominant costs to society.

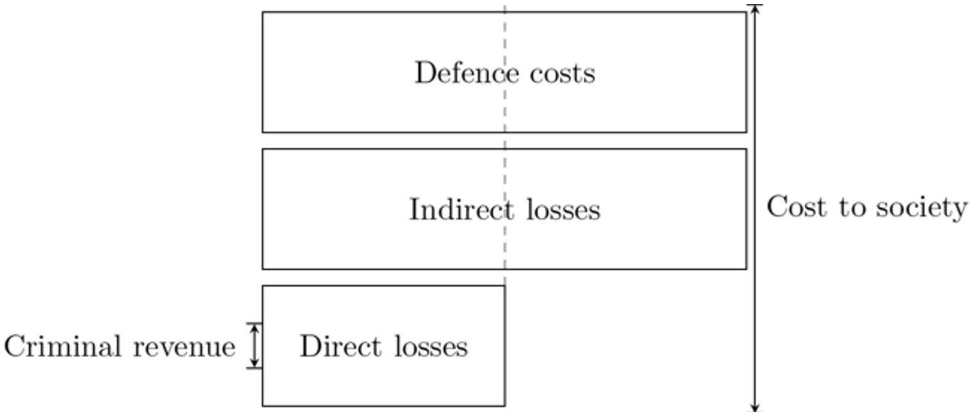

Figure 3. Security cost taxonomy (Anderson, 2013).

Notwithstanding Anderson's theoretical model dating from 2013. it lays the foundation for coherent information security cost determination and may offer the missing piece of the common cost model for information security (Brecht, 2013). However, it has not yet been clarified at which level the cost determination should take place in order to contribute to the cost-benefit calculation (Olifer et al., 2017). The main problem of cost determination is that it is characterized by a congestion of cross-organizational activities, often with outsourcing partners, together with a complex and diverse stack of security technology solutions, while pursuing to reduce risks to an acceptable level (Brecht, 2013; McLaughlin & Gogan, 2018; Olifer et al., 2017; Anderson, 2019). Apart from Anderson (2013), researchers have suggested several cost identification approaches: balance sheets, security life cycles, IT security processes, ISO/IEC 27001. Information Security Management System – Layers approaches (Brecht, 2013), one-off and recurring costs (Bruijn, 2010) and control-based approaches (Olifer et al., 2017). Brecht (2013) described four aspects of information security costs: 1) costs caused by incidents, 2) management costs, 3) security measure costs and 4) cost of capital, induced by information security risks. According to (Brecht, 2013), apparent indistinctness of cost definitions can limit the benchmarking of costs between organizations (Brecht, 2013).

Because of diverse cost models, Brecht (2013) suggested case-based approaches, e.g., cost benchmarking and internal materialized costs based on the context of planning, like budget planning vs. project planning. Demetz (2013) compared several information security investment approaches and observed issues concerning each individual approach, concluding recommending a combination of approaches like Brecht did (2013). The important observation was that one-time cost taxonomy (initial costs) was accounted in all approaches, but running costs (ongoing costs) were not encompassed equally (Demetz & Bachlechner, 2013). This observation supports the earlier observation regarding diverse classifications of cost inconsistency related to information security cost factors.

According Charoenthammachoke et al. (2020), 82 publications of different BCM fields, such like engineering and social science, were published between 1999 to 2018 – whereas 2015 was the year of the highest rate of BCM publications. Within the information security research domain, BCM research contributes to higher level questions with respect to resiliency, availability and disaster recovery from security incidents (Silic & Back, 2014). It appears that BCM has been quite a popular topic in information security research as more than one out of five (22.4% of 1588) research projects between 1977-2012 considered the perspective of BCM (Silic & Back, 2014). The research of BCM seems to cover a great variety of sub-topics: business process transaction security focusing on frauds, database security focusing on backups and continuity processes, knowledge management focusing on organizational awareness of continuity, message protection focusing on content protection, secure storage focusing on protecting records under any condition and systems integrity research of models and procedures that maintain integrity in situations of cyber-attack (Silic & Back, 2014). Despite diverse perspectives, the cost of BCM seems to be an unexplored topic within information security literature, or even within economics of information security literature. Considering the open avenue, this research may contribute to the economics of information security by presenting BCM activity costs as a type of defense cost and part of the security cost taxonomy (Anderson, 2013).

2.6 Cost of business continuity management

As observed in previous chapters, the identification of cost factors serves the overall cost-benefit analysis as a part of business planning in an organization. Against this background, the question arises to what extent this topic falls within the scope of BCM research. Niemimaa (2017) observed two dominant research themes among BCM scholars: technology and framework themes. Technology-oriented BCM research discusses the utilization of technology and alternatives to improve the reliability and availability of information systems (Niemimaa, 2017). The framework theme explores how to improve the organizational preparedness and ability to recover from disasters by methods and processes (Niemimaa, 2017). According to Turulja (2018), BCM literature concentrates mostly on case studies, proposing concepts and frameworks for BCM in information systems. Neither Niemimaa nor Turulja recognized research themes that explored cost of BCM in a similar fashion like, e.g., Ghoneim (2003) and Irani (2006). From the research point of view, it appears that the cost of BCM is not an apparent topic in BCM literature.

In order to understand how the concept of cost is embodied in BCM literature, the literature review was conducted by following the principles from Okoli (2010) and Wahono (2015). Since the BCM framework itself includes several sub-topics, as elaborated by (Herbane et al., 2004; Swartz et al., 2003), an extensive list of keywords was used to identify relevant business continuity articles for practical screening how the cost topic was discussed among scholars. The keywords were: BCM, business continuity management, DRP, disaster recovery planning, BCP, business continuity planning, ITCM, IT continuity management, ISCM, information systems continuity management, service continuity management, resiliency, recovery, crisis management. Each keyword was tested with cost keyword to capture any specific cost theme. The search was not limited to any research design, year or publishing year. Apart from IS research publishers, professional publications related to BCM and subtopics were included as well. Primary focus was on publishers related to information systems research and professional journals focusing on BCM topics. Google Scholar, AIS e-Library and the University of Turku search engines made it possible to reach all major article databases, such as Scopus and JSTOR. During the search, a total of 156 articles were identified for further review. Table 5 informs about the distribution of scientific publications, conference papers and professional journals, collected from various sources.

Table 5. BCM cost literature analysis source distribution by 156 publications.

Publication name	Total 156
Journal of business continuity & emergency planning	25
Proceedings of AIS conferences	19
Proceedings of the IEEE	16
Disaster Prevention and Management	9
Communications of the Association for Information Systems	6
Information Management & Computer Security	5
University publications	5
Computer Fraud & Security	4
Journal of Contingencies and Crisis Management	3
Network security	3
International Journal of Information Management	2
Association for Computing Machinery	2
Electronic markets	2
Int. J. Business Continuity and Risk Management	2
The International Journal of Logistics Management	2
Risk Management	2
American Journal of Economics and Business Administration	2
ASBM Journal of Management	1
MIS Quarterly	1
International Journal of Physical Distribution & Logistics Management	1
International Journal of Production Research	1
California management review	1
Decision Support Systems	1
Industrial Management & Data Systems	1
Safety Science	1
Long range planning	1
European Journal of Operational Research	1
Computers security	1
Business Horizon	1
IBM Systems journal	1
international journal of medical informatics	1
Journal of Homeland Security and Emergency Management	1
Business Process Management Journal	1
Information systems management	1
Disaster preparedness	1
Management Quarterly	1
Journal of Corporate Real Estate	1
Home Health Care Management & Practice	1
Facilities	1
Information systems security	1
Procedia Computer Science	1
Facilities Management	1
Journal of Information Technology Management	1
Work study	1
Review of Accounting Information Systems	1

Publication name	Total 156
Information systems	1
Information Systems Reliability	1
Australian Health Review	1
Public Works Management & Policy	1
International Journal of Business and Management	1
Business history	1
Information security journal	1
Journal of Information Systems Education	1
Campus-Wide Information Systems	1
International Journal of Information Systems for Crisis Response and Management	1
International Journal of Business and Social Science	1
Emergency management	1
EMC company publication	1
International Digital Government Research Conference	1
International Conference on Data Storage and Data Engineering	1
International Conference on the Quality of Information and Communications Technology	1
WHO publications	1
Procedia Technology	1
Proceedings of Australasian information security, Data Mining and Web Intelligence, and Software Internationalization	1

The BCM cost literature review included content analysis by NVIVO software. The content analysis purpose was to identify the systemic frequency of such key words that would help to detect cost related discussions from the articles. The first postulation was that the frequency of key words used in IS success literature, e.g., (DeLone & McLean, 1992, 2003; Petter et al., 2013; Urbach et al., 2012), could indicate the balance between positive and negative business impact. The word analysis was conducted by both using upside key words from the IS success literature and identifying antonyms (downside key words) (Table 6).

Table 6. Word counting of upside and downside key words.

Upside words (#1736)	Downside words (#7266)
profit, opportunity, save, success, advantage, grow	loss, risk, cost, fail, disadvantage, decrease

The content analysis disclosed 7266 citations of negative key words and 1736 positive keywords. The observation implies that BCM literature tends to orientate more downside business impacts, in the form of post-disaster losses, while publications citing upside business impacts and pre-disaster costs seem less common. This observation is not surprising considering the suggestion of Herbane (2004) based on which the primary goal of BCM is to preserve organizational value. For that reason, it is motivated by the potential loss, instead of, e.g., cost savings or value creation. A detailed screening supported the observations of Niemimaa (2017) and Turulja (2018) according to which BCM research discusses a wide range of topics, from frameworks and management discipline to IT service and technical topics of how to manage and control the potential negative impact of incident and business loss. The economic studies focusing on the cost of development or maintenance seem to be rare in this research area. In order to explore in more detail how BCM research discusses cost factors, a word frequency search was conducted by using cost factors identified in IT cost literature (Table 4). In addition, the phrase "cost of BCM" was also searched to identify similar themes like the research question of this research. During the process, each citation was reviewed and validated against the research context.

Table 7. Cost factors citations in BCM literature.

Cost factors	Publications	Cited	References
Maintenance costs	7	13	(Smart 1977; Post 1986; Gibb 2006; Bajgoric 2006; 2010; Lindström 2010; Rabbani 2016)
Infrastructure costs	4	8	(De Luzuriaga, 2009; Halliwell, 2008; Lindström, 2010; Sithirasenan, 2010)
Insurance costs	4	5	(Dey, 2011; Norrman & Jansson, 2004; Pauchant et al., 1991; Tammineedi, 2010)
Initial costs	3	26	(Foster & Dye, 2005; Post & Diltz, 1986; Rabbani et al., 2016)
Investment costs	2	6	(Faertes, 2015; Petroni, 1999)
Hardware costs	2	2	(Jordan, 2003; Rozek & Groth, 2008)
Training costs	2	2	(Carley, 1997)
Outsourcing costs	1	2	(Rabbani et al., 2016)
Personnel costs	1	1	(Post & Diltz, 1986)
Support costs	1	1	(Lindström 2010)
Purchase costs	1	1	(Lindström 2010)
Cost of BCM	1	1	(Rabbani et al., 2016)
Installation costs	1	1	(Zsidisin et al., 2005)
Ongoing costs	1	1	(Freestone & Lee, 2008)
Administration costs	1	1	(Gupta et al., 2011)
Staff costs	1	1	(Devlen, 2009)

In relation to prior listed IT cost (Table 4) classifications, no citations were found for any of following cost types from the total of 156 articles:

Analysis costs, exercise costs, management costs, disposal costs, lease costs, cost of business continuity management, upgrade costs, salary costs, modification costs, software costs, information security costs, business process costs, change costs, cybersecurity costs, procurement costs, offshore costs, decommissioning costs, consulting costs, testing costs, data conversion costs, change management costs, development costs, customization costs, project management costs

Out of 156 articles, a total of 27 articles contained a citation of cost factors. Only three authors were listed more than once: Post (1986), Lindström (2010) and Rabbani (2016). The literature review disclosed only three research articles where the cost factors were considered as a part of the proposed models. Out of 27 articles all but one case, cost factors were cited, but not defined or explained on detailed manner. Most of the cost factors were not cited at all as we can observe from table 7. The literature review suggests strongly that determining the cost of BCM has not been researched extensively.

Post (1986) introduced the stochastic dominance analysis to evaluate the full loss distribution. According to Post (1986), the reduction of loss through an effective business continuity plan should be evaluated against the cost of maintaining the plan. Such costs can include manual work costs, recovery site costs and annual subscription or maintenance costs. In his research, Post (1986) does not examine the cost factors for the business continuity plan maintenance but rather focuses on the costs incurred due to a disaster. The cost-benefit model provided by Asnar (2008) discusses how to analyze risks and treatments alongside strategic objectives from a socio-technical perspective. In the model, costs are discussed in the form of treatment costs that are caused by technical solutions like firewall or redundant database and services. Asnar's (2008) research does not specify or categorize cost factors or discuss those at any detailed level. Rabbani (2016) suggested a cost-benefit framework for a selection of three strategies: BCM, outsourcing and insuring based on an organization’s characteristics, available data and desirable level of continuity. The model proposes a fuzzy-based method to capture incomplete data in the form of triangular fuzzy numbers as well as the use of current and future values, including inflation rates (Rabbani et al., 2016). Rabbani’s model from 2016 captures BCM lifecycle costs by covering pre-disaster activities, during the disaster activities and post-disaster activities, proposing the most appealing strategy to respond to a potential disaster. Rabbani (2016) suggests that the economics of BCM are driven by the anticipated recovery time and recovery point objectives. The realization of these objectives is often restricted by the maturity of BCM, budget constraints and cost of BCM functions (Rabbani et al., 2016).

Rabbani’s (2016) research discusses the cost of BCM by defining cost types for BCM implementation. According to Rabbani (2016), the most important input for business continuity planning is the budget, which also reflects the risk appetite of the company. As an observation, the cost factor provided by Rabbani (2016) (Table 8) appears to have an inconsistent taxonomy of different cost factors, e.g., fixed costs are identified, but variable costs are not defined. In a similar way, indirect costs are defined but not the direct cost factors. Interestingly, a few cost factors are listed separately, even though they appear to have the same characteristic, e.g., cost of failure considers both expenses and losses but does not include overtime payments caused by an incident. Considering the scope of research “Costs of BCM implementation to respond to a disaster”, it is debatable to include the cost of failure class into the model as BCM implementation implies the scope of pre-disaster activities. As an example, Anderson (2013) makes a distinction between cost of defense and direct/ indirect losses. Despite a few arguable details, Rabbani's research (2016) lays the foundation for the cost determinants of BCM that are discussed in the chapter 3.1.

Table 8. Costs of BCM implementation to respond a disaster as defined by Rabbani (2016).

Cost factors	Description
Cost of failure	Productivity loss, revenue loss, financial performance, damaged reputation, other expenses caused by the failure
Cost of hire BCM new members	Includes the costs to hire new members, BCM experts and researchers
Cost of initial functions in BCM	Includes the costs of operations to identify all functions of organization, determining key outputs a of organization, conducting trainings for the staff to get familiar with the concept of BCM, costs of embedding competence and awareness in organization
Recovering functions indirect costs	Costs from pre-disaster, post-disaster and during disaster activities to recover vital process in a predefined time, e.g., training, back-ups, emergency extra work
Recovering functions fixed costs	Hiring or renting new facilities or equipment based on BCM objectives, e.g., renting space to continue operations at another place
BCM revision and maintenance costs	Costs for reviewing the business continuity programs and developing BCM maintenance process
Overtime payment	Compensation of the products or services, not delivered in time stipulated in the contract after disaster period

3 Theoretical model and hypotheses

3.1 BCM activity cost model

There are several broad definitions for business continuity management, depending on whether the scope of research is on social aspects, technology or developing models of continuity (Niemimaa, 2015). Considering this and challenges of how to determine cost taxonomies for information systems (Irani et al., 2006), conceptualizing the cost of BCM activities is a prerequisite before operationalizing variables for hypothesis testing and later for operationalizing variables. To resolve the given challenge, this research proposes the merge of integrative framework of business continuity (Niemimaa, 2015) in line with IS cost taxonomy (table 4) and the cost of information security (Anderson et al., 2013), into the theoretical framework of *the total cost of business continuity management* (Table 9*).*

The framework is an overarching view on business continuity cost factors to clarify conceptual issues between terminologies. Direct (Di_{cl}) and indirect (Id_{cl}) cost and loss factors are incorporated into the business continuity management lifecycle, considering time perspectives of cost/loss factors before and after an incident. In other words, *the total cost of business continuity* is a sum of pre-incident (Pr_c) and post-incident **(**Po_{cl}) costs (c_n) and losses (l_n), taking into account the direct and indirect nature of the costs and losses (table 9). In this research, the term cost (c_n) is defined as *operational expense of acquiring and using resources* (Cooper & Kaplan, 1992), whereas the term loss (l_n) is defined as *damage to the performance, reputation and value* (Anderson, 2019). The model assumes cost (c_n) and loss (l_n) factors as a sum of sub-cost factors as suggested by literature, e.g., Rabbani (2016), Anderson (2013) and Irani (2006). As an example, installation, configuration and customization work cost factors (Oesterreich & Teuteberg, 2017) are assumed to be subtypes of *implementation and development work costs* (c_5) in table 9.

The following sections will discuss how business continuity lifecycle costs can be systematized into two top-level categories and four sub-level categories, and how the various cost and loss factors related to the direct (Di_{cl}) and indirect (Id_{cl}) cost categories fit into this framework. The indexing numbering of the cost (c_n) and the loss (l_n) factors follows the lifecycle approach and is disposed from the initial to the ongoing stage and from there to the intermediate and post stages. The indirect cost

(Id_{cl}) category is organized before the direct cost (Di_{cl}) category, suggesting that work activities are manifested before acquiring IT resources (Wade & Hulland, 2004) for business continuity. This belief is based on the assumed causation between cost objects, activities and resources (Wegmann & Nozile, 2008) driven by situational requests that trigger activities to consume resources (Cooper & Kaplan, 1988). Considering loss factors (l_{n}), it can be argued that while there can be a causation between indirect and direct loss factors, the model places the cost relation between activities and resources before loss factors. This positioning is based on the suggestion provided by Anderson (2013) to distinguish direct and indirect losses depending on whether the damage can be directly attributed to the victim or not. Pre-incident loss factors, such as productivity losses during systems development (Irani et al., 2006) or sunk costs due to a failed information systems project (Dwivedi, 2015) are excluded from the model because the business continuity research literature does not support their inclusion. As an example, Rabbani (2016) defines productivity costs (l_4) as a consequence of a downtime or failure in post-incident phase but not in the pre-incident phase as a design error.

Table 9. Suggested framework of the total cost of business continuity management.

	Pre-incident (Pr_c)		**Post-incident (Po_{cl})**	
	Initial (In_c)	Ongoing (On_c)	Intermediate (Im_{cl})	After (Af_{cl})
Indirect (Id_{cl})	Analysis work costs (c_1) design work costs (c_2) Implementation and development work costs (c_3)	Awareness and training work costs (c_6) Exercise, test, and maintenance work costs (c_7)	Incident management work costs (c_{10}) second party material losses (l_1)	Recovery, restoration, and financial claims work costs (c_{12}) Incident review and improvement work costs (c_{13}) Future revenue and value losses (l_3)
Direct (Di_{cl})	Hardware/ software purchases costs (c_4) Communication and infrastructure purchases costs (c_5)	Hardware/ software maintenance costs (c_8) Communication and Infrastructure maintenance costs (c_9)	Provisional software, hardware and utility resources purchases costs (c_{11}) First party material losses (l_2)	Hardware/ software purchases costs (c_{14}) communication and Infrastructure purchases costs (c_{15}) Productivity losses (l_4) Financial performance losses (l_5)

c = cost, *l* = loss

The total cost of the business continuity framework assumes that pre-incident costs (Pr_c) reflect the lifecycle management of information systems from the system development to the maintenance phase (Ghoneim & Irani, 2003). The pre-incident category (Pr_c) considers cost factors suggested by, e.g., Heikkilä (1995), Irani (2006) and Oesterreich (2017), among other scholars, who have studied cost classification in information systems (table 3). In the initial stage (In_c), business continuity activities produce work efforts within an organization, causing indirect costs (Id_c). This subcategory incorporates three activity cost factors. First, the business impact analysis (c_1) (Wan, 2009) second, the development of response and recovery strategies (c_2) (Shropshire & Kadlec, 2009) and third, the implementation of processes and systems (c_3) (Bajgoric, 2009). The framework assumes that these activities consume both internal and external resources for consultation, project management, systems installation, process restructuring and change management work, to name just a few work types (Irani et al., 2006; Love et al., 2006; Oesterreich & Teuteberg, 2017). The work products of business continuity activities may consist of several layers of systems that complement each other against possible incidents (Baham et al., 2017). Such solutions may contain a combination of, e.g. back-up storage, high availability networks and virtual application infrastructure, just to mentioned a few of the possible continuity solutions (Baham et al., 2017). The implementation of these technologies generates direct costs (Di_c) in the form of purchasing or leasing ready-made or customized software and hardware (c_4), as well as infrastructure and communication costs (c_5) (Oesterreich & Teuteberg, 2017).

Ongoing costs (On_c) are generated after the initial work activities are completed and the planned solutions are in operation. Within this setting, indirect costs (Id_c) are incurred through BCM awareness programs and training (c_6) for incident response, backup and recovery procedures that are embedded into corporate culture and operations (Shropshire & Kadlec, 2009). Maintaining effective continuity capability requires continuous practice; testing and updating (c_7) of plans and systems (Shropshire & Kadlec, 2009; Ueno et al., 2018), is another root for indirect costs (Id_c) (Kappelman et al., 2018; Oesterreich & Teuteberg, 2017). During the ongoing phase, direct costs (Di_c) like the cost of software and hardware maintenance (c_8) are mostly caused by system modifications and upgrades, often driven by business changes and system reliability issues like defected hardware and software bugs (Ghoneim & Irani, 2003; Irani et al., 2006). The usage of utility services, e.g., electricity, insurances, system licenses and network leases, generates communication and infrastructure costs (c_9) (Ghoneim & Irani, 2003; Irani et al., 2006). Based on the above suggestions, we can synthesize pre-incident costs (Pr_c) through Equation 1 below, which has the purpose of simplifying the matrix view to a linear representation, but more importantly, provides a basis for logical reasoning to determine the cost of BCM later in this research.

Equation 1. Theoretical composition of the pre-incident costs

$$Pr_c = In_cId_c + On_cId_c + In_cDi_c + On_cDi_c$$

$Pr_C = Pre\ incident\ costs$
$In_c = Initial\ costs$
$On_c = Ongoing\ costs$
$Id_c = Indirect\ costs$
$Di_c = Direct\ costs$
$c = Costs$

All costs triggered by and incurred during an incident (Im_{cl}), up to the point after the incident (Af_{cl}) ends and recovery begins, are considered post-incident costs (Po_{cl}). We can assume that costs are already generated at the moment when the organizational resources for incident management are allocated and that they accumulate during the incident until the point when the incident is resolved. Incident management activities (c_{10}) like communication, detection, damage-containing and implementation of workarounds and temporary solutions (Anderson, 2013; Niemimaa, 2017) are the source of indirect costs (Id_c). Depending on the situation, incident resolution may require the purchase of temporary technology and the lease of additional utility services (c_{11}) to enable workarounds and continue operations (Niemimaa, 2017). In addition to the costs caused by an incident, an organization may also suffer material losses, such as the loss of data, availability and productivity during an incident (Anderson, 2013; Rabbani et al., 2016). As a result of these direct losses (Di_l), an organization may not be able to deliver products and services to the customers, which indirectly (Id_l) causes material losses to the second party (l_1) (Anderson, 2013; Rabbani et al., 2016). These costs are named in this research as intermediate costs (Im_{cl}), to stress the timing when the costs are incurred – that is during the incident.

After the incident is under control, recovery and restoration work (c_{12}) can begin. Activities such as rebuilding, reinstalling, testing and restoring systems, as well as taking care of liabilities, are the source of indirect costs (Id_{cl}) (Niemimaa, 2017; Rabbani et al., 2016). Depending on the severity of an incident, restoring normal operations may require the purchase or lease of new software and hardware (c_{14}), as well as communications and infrastructure services (c_{15}) (Niemimaa, 2017; Rabbani et al., 2016). In order to manage the risk of future incidents, the analysis and improvement of systems and processes (c_{13}) can generate additional indirect (Id_c) and direct costs (Di_c) (Niemimaa, 2017; Rabbani et al., 2016).

The framework assumes that the first- and second-party material losses from intermediate-incident phase (Im_{cl}) are traced back and translated into indirect (Id_{cl}) and direct (Di_{cl}) financial losses. We can assume that the extent of indirect losses depends on how well organization handled incident, as damaged reputation amid suppliers, customers and financial markets, can affect negatively future revenue opportunities, credit ratings and share value (l_3) (Anderson, 2019; Knight et al., 1997; Rabbani et al., 2016). Beside productivity losses (l_4), invoicing losses, charge backs, extra shipping costs, legal costs and other compensatory payments, can affect negatively on overall financial performance (l_5) (Irani et al., 2006; Anderson, 2013; Rabbani et al., 2016). Reflecting above descriptions of post-incident cost and loss factors, we can synthesize the following Equation 2.

Equation 2. Theoretical composition of the post-incident costs

$$Po_{cl} = Im_{cl}Id_{cl} + Af_{cl}Id_{cl} + Im_{cl}Di_{cl} + Af_{cl}Di_{cl}$$

$Po_{Cl} = Post - incident\ costs\ and\ losses$
$Im_{cl} = Intermediate\ incident\ costs\ and\ losses$
$Af_{cl} = After\ incident\ costs\ and\ losses$
$Id_{cl} = Indirect\ costs\ and\ losses$
$Di_{cl} = Direct\ costs\ and\ losses$
$c = Costs$
$l = Losses$

Given the above observations on how indirect (Id_{cl}) and direct (Di_{cl}) cost determinants can be associated with pre-incident (Pr_c) and post-incident (Po_{cl}) determinants, we can assume that addition of all determinants ($c_1 - c_{15}$) and ($l_1 - l_5$) over the lifecycle of business continuity would logically result in the total cost of business continuity management (BCM_{Tc}). Therefore, we can assume that the total cost of business continuity management (BCM_{Tc}), is the sum of pre-incident cost determinants (Pr_{c}) and post-incident determinants (Po_{cl}) as proposed in the following Equation 3.

Equation 3. Theoretical composition of the total cost of business continuity management

$$BCM_{Tc} = Pr_{\mathrm{c}} + Po_{\mathrm{cl}}$$

In line with the proposed composition, we define the total cost of BCM:

The cost of business continuity management is the sum of all pre- and post-incident costs and losses.

The equation of the total cost of BCM provides a holistic a perspective on business continuity management cost research and can be used for further research designs when one needs to understand the possible cost factors. Although this perspective could be a very interesting research topic as whole, the research question *how to determine the cost of BCM activities in IT services* addresses the scope to the specific activities suggested by the literature (table 1). As literature suggests, BCM can take many forms of implementation, depending on the nature and complexity of the business, the inherent threats and their sources available, but mostly literature refers to preparation activities for the worst-case scenario as we observed in chapter 1.2. That implies that the cost of BCM activities belongs under pre-incident category of costs. Over time, BCM has evolved from crisis management and disaster recovery planning to a holistic management framework (Herbane, 2010) that includes sequences of activities to plan, build and maintain organizational capabilities against major incidents and disasters. If we consider the unanimity of scholars regarding BCM activities that directly enhance an organization's survivability (Boehmer, 2009; Knight et al., 1997) we can argue that the cost of BCM activities can be derived from five distinct activities that are performed in a specific order prior to the occurrence of an incident (Arduini, 2010; Geelen-Baass & Johnstone, 2008; Herbane, 2010; Randeree et al., 2012). Given our logical deduction from the literature theories BCM, we argue that the independent variables of the BCM activity costs are the five activities introduced in Table 1. Equation 4 presents these variables.

Equation 4. Independent variables of BCM activities

$$A = a_1 + a_2 + a_3 + a_4 + a_5$$

$$\begin{aligned} A &= BCM\ activities \\ a_1 &= Understand\ the\ organization \\ a_2 &= Determine\ the\ business\ continuity\ strategy \\ a_3 &= Develop\ and\ implement\ the\ plan \\ a_4 &= Embedded\ business\ continuity\ into\ organization \\ a_5 &= Exercise, test\ and\ maintain\ the\ plan \end{aligned}$$

Unlike direct costs that can be tied to specific hardware or software, we can propose that the cost of BCM is the result of indirect costs of BCM activities, and since these activity costs are consequently caused by different BCM activities, we argue that BCM activity costs in IT services can be determined by the observation of cost variation of each distinct BCM activity as well as difference between IT services who implemented BCM in their services in relation to the those who do not implement BCM. Following of this definition and considering the total cost of BCM framework (BCM_{Tc}), we can postulate that the business continuity management activity costs (BCM_{Ac}) are the subset of pre-incident costs (Pr_c) that are caused by organizational inquiry on IT service continuity development and maintenance.

Equation 5. The BCM activity cost function

$$BCM_{Ac}(f) = A(x) + Pr_c(y)$$

$BCM_{Ac} = BCM\ activity\ cost$
$A = BCM\ activities$
$Pr_c = Pre - incident\ costs$
$c = Costs$

It can be argued, categorically, that BCM activities are the cost determinants on IT resources and in return IT resources are cost drivers on BCM activities. In this progress BCM activity cost (BCM_{Ac}) is a function of the relation between BCM activities (A) and pre-incident costs (Pr_c), when pre-incident costs (Pr_c) are equal to initial costs (In_c), ongoing costs (On_c), indirect costs (Id_{cl}), direct costs (Di_{cl}) and BCM activities (A) are equal to analysing activity (a_1), designing activity (a_2), implementing activity (a_3), embedding activity (a_4), maintenance activity (a_5). (Table 9). The BCM activity cost function can be visualised as BCM activity cost model, presented in the figure 4.

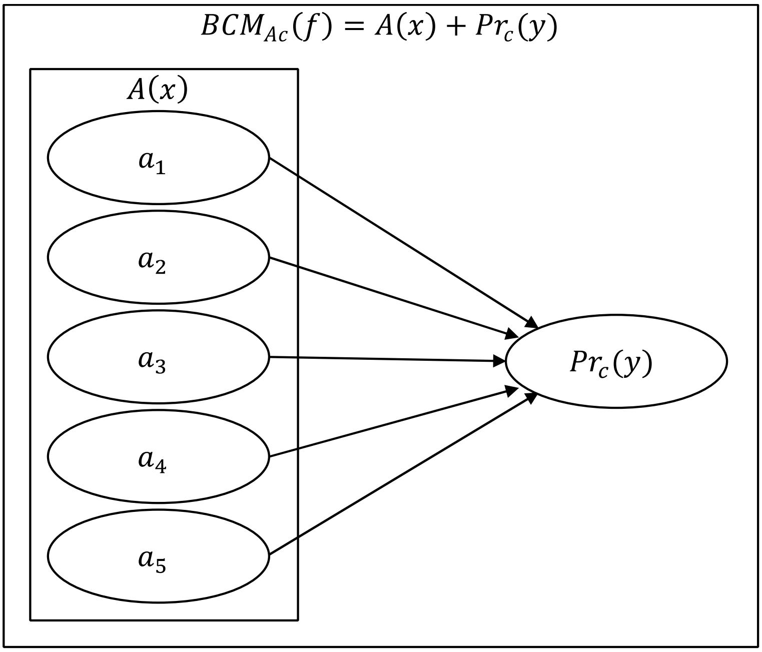

Figure 4. The BCM activity cost model.

3.2 Hypothesizing the BCM activity costs in IT services

In relation to the main research question on *how to determine the cost of BCM activities in IT services*, we theorize that BCM activity cost can be observed by measuring BCM activities (list 1) effect on IT service costs. These determinants were introduced and discussed in the earlier chapter 2.2, and later in the chapter 4.7.2.

List 1. BCM activities (A)

$a_1 = Understand\ the\ organization$
$a_2 = Determine\ the\ business\ continuity\ strategy$
$a_3 = Develop\ and\ implement\ the\ plan$
$a_4 = Embedded\ business\ continuity\ into\ organization$
$a_5 = Exercise, test\ and\ maintain\ the\ plan$

Reflecting upon earlier chapters, we assume that each BCM activity ($a_1 - a_5$) can operate as an independent cost variable and thus be observable in relation to other costs in an organization. As the literature review implies, the cost of BCM can be affected by several factors. Therefore, additional sub-research questions have been outlined in this research to understand different perspectives. Each question discusses the type of costs that can be affected by the BCM activities. The first sub-question considers if we can observe specific BCM activity costs in relation to other IT costs. We assume that organizations can measure the cost of BCM when they have employed BCM activities defined by BCM scholars (Table 1). If we can measure indirect costs by observing specific activities as suggested by Cooper and Kaplan (1988), we could confirm the categorical nature of BCM activities discussed in BCM literature, but, most importantly, suggest how to measure the cost of BCM.

Considering the main argument of the present research, according to which the cost of BCM can be determined by observing BCM activities and assuming that the cost of consumed resources can be assigned back to the BCM activities and from there traced all the way to the IT services (Cooper, 1998; Cooper & Kaplan, 1988, 1992), we should be able to observe distinct cost behavior on each BCM activity in IT services. The absence of assumed pattern of costs would either imply issues on how BCM activities have been adopted in an IT service or regarding the theoretical model how BCM activities have been defined. For example, if BCM activities a_1, a_2 and a_3, presented in the table 9, correlates with IT costs and BCM activities $a_4\ and\ a_5$ (Table 9) do not, it would suggest that only three BCM activity types a_1, a_2 and a_3 produces observable costs. This would lead to the conclusion that instead of five BCM activities only three activities have tangible effects on company IT services' continuity capability. To test this assumption, the hypothesis, where BCM activities are treated as an independent variable (IV) and IT service costs as a dependent variable (DV), can be suggested. The goal in this case would be to determine how much of the cost variation in the dependent variable can be explained by all independent variables ($a_1 \rightarrow a_5$). If we can observe a distinct association between IT service costs and each BCM activity, we can also argue about the inclusion of each activity when determining the cost of BCM. Above logic can be translated into the following question:

Sub-research question 1 (SRQ1): How much of the IT service cost variation can be explained by BCM activities?

If the claim of sub-research question 1 (SRQ1) is supported, it may suggest that BCM activities causes observable costs for an IT organization. However, confirming the correlation between IT service costs and BCM is only a partial view when determining the cost of BCM. The second sub-question (SRQ2) pursues to understand the correlation between BCM activities and the cost of different IT resources types discussed by e.g., Ross (1996) and Saunders (2016). The ability to observe the cost of each resource type caused by BCM activities could improve the robustness of the suggested model as it may uncover how the costs are distributed between different resource types, thus helping to predict possible future cost breakdown for BCM. Understanding this factor could allow projecting how specific resource costs would accumulate over time while performing each BCM activity.

As with processes in general, we can assume that BCM activities require human, technological and organizational resources (Ross et al., 1996; Bharadwaj, 2000; Wade & Hulland, 2004). Consequently, it is important to understand how BCM activities consume different resources. Considering the suggested interdependencies between BCM activities and resources, we should be able to observe the correlation between BCM activities and the cost of resources (Cooper & Kaplan, 1988). Based on the above, we suggest testing to what extent IT resource cost variation can be explained if BCM activities ($a_1 - a_5$) are treated as an independent variable (IV) and specific resource cost types as a dependent variable (DV). We suggest the inclusion of the following three IT resource perspectives: human resources, technology resources and organizational resources in order to compare possible differences between groups (Ross et al., 1996; Bharadwaj, 2000; Wade & Hulland, 2004).

Cross-organizational activities can generate labor costs by a company's workforce with fixed or part-time contracts as well as external employees, e.g., sub-contracting and on-site consultancy (Brecht, 2013; McLaughlin & Gogan, 2018; Olifer et al., 2017; Anderson, 2019). Considering this, testing the correlation between IT human resource costs and BCM activities treating BCM activities as an independent variable (IV) and human resource costs as a dependent variable (DV) can be a sufficient approach. Correspondingly, we can suggest investigating the correlation between BCM activities and IT technology resources, such as software, hardware, infrastructure and communication costs, treating BCM activities as an independent variable (IV) and technology resource costs as a dependent variable (DV). Considering internal and external relationships, we can assume that the cost of IT service is affected by the degree of outsourcing or insourcing. Hence, it is reasonable to test how much BCM activities correlate with the cost of organizational resource costs (Chang, 2012; Kappelman, 2020) by treating BCM activities as an independent variable (IV) and IT organizational resource costs as a dependent variable (DV). Considering the discussion of IT resource types following question can be raised:

Sub-research question 2 (SRQ2): How much of the IT cost variation in IT resource types can be explained by the BCM activities?

The third sub-research question (SRQ3) considers the implication of factors that are not directly related to, but consequently affect the implementation of BCM. According to Petter (2013), several factors can affect an information system management: external parties, the degree of technology sophistication and the type of information system used by an organization. We can conceptualize the IT service as a manifesto of circumstantial organizational requirements that influences the IT service provider’s choice of technologies used, ambition towards customization and service levels expected by customers or multiple customers (Mora et al., 2014, 2015). IT service consists of one or more IT systems built upon a combination of people, processes and technology, defined in a Service Level Agreement (Mora et al., 2014, 2015). As noticed in previous chapters, BCM is subject of technical and organizational conditions. For this reason, it is fair to assume that IT continuity plans are attributed by the characteristics of each IT service (Bajgoric, 2009).

Considering the IT service design perspective discussed in the chapter 2.3. we can observe several factors that are likely to affect the IT service design, such as the purpose of software, collaborative use of systems, customizations, collaboration between suppliers, intellectual property rights and overall expectations on performance – whether the system is hosted internally or outsourced. It is reasonable to argue that designing an IT service is a complex process as it involves interactions of several humans and various levels of customized technology components. While the BCM framework can be expressed as an organization’s independent construct, we can assume that diversity of IT service designs affects BCM activities. Consequently, we can assume differences between BCM activity costs in different IT service designs. To observe differences between costs, the comparison of different IT service designs determined by an organization while taking into consideration the type of systems, users, customization, security and any other distinct factors defined in service level agreements can be suggested. As the diversity of IT service designs can be significant, it is possible to create hypothesis to each design type. Because IT service design testing is not the main goal this research takes practical approach and limits hypothesis testing to the selected design categories, discussed later in the operationalization chapter. Therefore, we can propose the hypothesis based upon which BCM activities are treated as an independent variable (IV) and IT costs are treated as a dependent variable (DV), grouped by selected service designs to observe cost variation between different IT service designs. Reflecting upon this, the third sub-research question ponders a correlation between the cost of BCM and different IT service designs:

Sub-research question 3 (SRQ3): How much of the IT cost variation in the different IT service designs can be explained by BCM activities?

The above remarks can provide rationale for the three respective sub-research questions and on how to postulate associations between variables in different contexts. Sub-research questions have been created to test different perspectives and by that assumed to improve the accuracy of analysis. For this reason, research hypotheses have been derived from the sub-research questions. During this research, they are to be used for discussion on how to determine the cost of BCM in IT services. On the basis of the literature review the absence of prior research of the relation between BCM and IT costs limits possibility to make predictions regarding a positive or negative association. This type of prediction is usually based on past research, accepted theory, extensive experience, or literature on the topic and guidance on the creation of a directional hypothesis (Salkind, 2010). In comparison to directional hypothesis, nondirectional hypothesis predict the actuality of change, relationship, or difference between variables, but do not specify the magnitude of such associations in either direction.

Due to the absence of reference data to create a directional hypothesis, we anticipated the observation of associations between suggested dependent and independent variables and suggested a nondirectional format of hypothesis in earlier paragraphs (Salkind, 2010). Consequently, this directs us first to estimate the likelihood of existence concerning assumed associations between suggested variables before we can make any further interpretation of any result. A null hypothesis (H0) chases the association between variables of groups, inherently assuming that there are no differences between groups, or in this case – there is no cost difference between IT service with BCM activities and IT service without BCM activities (Salkind, 2010). If a null hypothesis is rejected i.e. it is unlikely that results are random observations, then an alternative hypothesis would become effective, suggesting that further discussion of practical significance and coefficients of BCM activities is statistically supported (Salkind, 2010). Considering the earlier discussion of sub-research questions and hypothesis perspectives, we propose five null hypothesis–alternative hypothesis pairings with following approach regarding the testing difference between IT services without and with BCM activities in different IT cost contexts:

Table 10. Null hypothesis–alternative hypothesis pairings.

Sub-research questions	**Hypothesis**	**Cost category**	**Null hypothesis**	**Alternative hypothesis**
SRQ1	H1	IT service cost	There is no IT service cost difference between IT service with BCM activities and IT service without BCM activities	There is observable IT service cost difference between IT service with BCM activities and IT service without BCM activities in each strata
SRQ2	H2	Human resource cost	There is no human resource cost difference between IT service with BCM activities and IT service without BCM activities	There is observable human resource cost difference between IT service with BCM activities and IT service without BCM activities in each strata
SRQ2	H3	Technology resource cost	There is no technology resource cost difference between IT service with BCM activities and IT service without BCM activities	There is observable technology resource cost difference between IT service with BCM activities and IT service without BCM activities in each strata
SRQ2	H4	Organizational resource cost	There is no organizational resource cost difference between IT service with BCM activities and IT service without BCM activities	There is observable organizational resource cost difference between IT service with BCM activities and IT service without BCM activities in each strata
SRQ3	H5	Cost by IT service designs	There is no IT service design cost difference between IT service with BCM activities and IT service without BCM activities	There is observable IT service design cost difference between IT service with BCM activities and IT service without BCM activities in each strata

4 Research methodology

4.1 Philosophical grounding

Ontology asks what exists in relation to the observer, what the world is like, how to classify physical and social reality (Orlikowski & Baroudi, 1991). Whereas ontology defines the vocabulary and a set of axioms or rules how to name or call the reality, epistemology considers the problem of how to build knowledge of the reality. Ideally, a researcher pursues impartial and transparent knowledge creation to satisfy scientific inquiry. However, perception of reality at the individual level may distort the scientific approach and the overall interpretation of observations (Hirschheim, 2000). Inherent biases may misdirect a researcher's decisions. Thus, methodological choices are necessary to rely on epistemological considerations by attempting to answer the question: "How do we know what we know?" (Hirschheim, 2000).

Since the advent of post-positivism in the 1980s, methodological pluralism has been promoted by creating new opportunities to adopt different philosophical viewpoints in IS research (Hirschheim, 2000). This would mean that an information systems researcher could take an objectivist position and assume that social constructs have properties of the natural world, and therefore apply paradigms from natural science (Hirschheim & Klein, 1989). At the other end of the spectrum, researchers may view social phenomena as inherently human constructs and thus, knowledge can be gained by studying the subjective experience of individuals (Hirschheim & Klein, 1989). A researcher who is observing reality through the lens of positivism prefers empirical quantifiable evidence to test hypotheses derived from research questions (Burton-Jones & Lee, 2017; Kettinger & Lee, 1997; Lee & Baskerville, 2003; Orlikowski & Baroudi, 1991; Paré, 2004). In this paradigm, causality is assumed to be true unless value-free examination of fixed relationships through quantitative data and structured instrumentation falsifies it (Orlikowski & Baroudi, 1991).

It has been argued that the socio-technical nature of information systems limits possible quantitative statements as observations are inherently an incomplete representation of reality (Kaplan & Duchon, 1988). Examples like quasi-experimental research (Venkatraman & Zaheer, 1989), understanding IT outsourcing determinants (Loh & Venkatraman, 1992), moderating effect testing (Agarwal,

1998) and determining the links between contextual factors and IT's performance impact (Li & Richard Ye, 1999), show that despite socio-technical context limitations, quantitative research can support IS research approaches to some degree. Notwithstanding challenges of quantitative approaches, e.g., instrument validation (Boudreau, 2001), measurements (Burton-Jones & Lee, 2017) and statistical power (Baroudi, 1989), the positivism paradigm and quantitative methods are popular in information systems research, mainly because positivism has been considered a more scientific approach than the other paradigms (Siponen & Tsohou, 2018). Siponen and Tshohou (2018) argued that many assumptions that made the positivism paradigm as a more scientific approach than other paradigms were not justified. Moreover, the positivist tradition of empirical research values qualitative methods and observations on the individual case on an equal footing with quantitative methods (Siponen & Tsohou, 2018).

Considering relation between positivism and this research, arguing a causal link between intangible constructs of BCM activities and IT costs, similar to objects in the natural world, can be intuitively problematic in a social context (Wegmann & Nozile, 2008). In this context, social reality manifests itself as an observable code of linguistic categories, cultural forms, routines, norms and definitions such as cost taxonomies and IT processes (Krauss, 2006). Code transforms into meaning that guides individual response and, on a large scale, society's behavior, with BCM being a good example of such code guiding IT organizations (Krauss, 2006). As a social construct, BCM is a sum of ontologically independent "codes", where codes refer here to any activity that could be observed (Mingers et al., 2013). Because BCM activities can theoretically change business operations and alter real objects such as information systems through individual and organizational behaviour, it can be argued that BCM is a real and observable, yet idealized assumptions of causal relations (Mäki, 2020). Simply because the actuality of the cost and BCM are undoubtedly purely human-made constructs with imperfections.

This research assumes that the association between IT costs and BCM activities emulates the activity-based costing theory (Cooper & Kaplan, 1992). While the prior knowledge and assumptions of reality are solely based on social constructs, the underlying paradigm is grounded on the premise of cause and effect relationship between cost objects, activities and resources (Wegmann & Nozile, 2008). While the hypothetical relationships between IT cost and BCM activities may merely mimic causality, lacking the actual causation like in natural sciences, structured interactions between suggested institutionalized social mechanisms can be uncovered and false hypotheses can be eliminated by quantitative methods (Mingers et al., 2013). All in all it can be agreed that determining the cost of BCM may be a search for a social construct (Becker, 2005; Pentland & Feldman, 2005). This research pursues inductive reasoning derived from statistical analysis of actual cost data from real life phenomenon (Tsang & Williams, 2012). To some extent the research is leaning on positivist tradition as it seeks value free quantification of empirical evidence to test hypotheses as discussed earlier in this chapter. This can explain methodological choices and assumptions made in this research.

4.2 Quantitative case study research approach

At a high level, research methodology outlines the way in which research should be conducted in relation to the scientific discipline and research question at hand (Jenkins, 1985; Orlikowski & Baroudi, 1991). In information systems science, a variety of accepted methodologies could be explained mainly because of the socio-technological nature of this discipline (Kilani, 2016). Whether information systems researchers prefer a pluralist approach (Kaplan & Duchon, 1988; Mingers, 2001) or experimental research (Levy & Ellis, 2011), methodological decision should be driven primarily by research goals (Jenkins, 1985). During the research process, new viewpoints were raised and the research question evolved to the final format "H*ow to determine the cost of BCM in IT services?"* and three sub-questions to take a specific perspective on the cost determinants in IT services (list 2).

List 2. Research questions

1. Main question: *How to determine the cost of BCM activities in IT services?*
2. Sub-question: *How much of the IT service cost variation can be explained by BCM activities?*
3. Sub-question: *How much of the IT cost variation in IT resource types can be explained by the BCM activities?*
4. Sub-question: *How much of the IT cost variation in the different IT service designs can be explained by BCM activities?*

Consideration of the semantics of the first segment of the main research question "*How to determine …*" suggests exploration of possible methods for measuring the later part of the question "*…the cost of BCM in IT services?"*. The open structure implies features of the qualitative research tradition as suggested by Venkatesh, (2016). Although the main research question does not have the characteristics of investigating quantitative research, the sub-research questions indicate the goal of investigating the relationships between variables: IT costs and BCM activities. According to Venkatesh, (2016) the use of the two types of research question semantics suggests the inclusion of both qualitative and quantitative methods which indicates mixed method research. The aim of quantitative research questions is to measure, compare and find associations between variables, while qualitative research questions are looking for a broader perspective, evolving when exploring the phenomenon (Venkatesh et al., 2016). The total cost of business continuity management framework (Table 9) is the product of literature review and as such can offer an answer to the qualitative question. Sub-questions purpose it find supportive evidence if the qualitative framework can be supported. Considering the semantic perspective, the mixed methods approach may seem reasonable given the syntax of the main research question (Venkatesh et al., 2016), however this study places more emphasis on quantifiable sub-questions that can be validated in a real-world setting. Therefore, the quantitative approach leads the research design.

Reflecting on the research questions and suggested hypothesis testing, it is apparent that the cost of BCM has not been a broadly studied topic in IS literature. The literature review suggests that the leading publications of IT cost and economics of security are concentrated around only a few researchers, e.g., Irani (2006), Love (2006) and Anderson (2019). Consequently, the cost of IT service operations and BCM are not a common topic in information systems research. Economics of information security literature extensively discuss security costs, methods and taxonomies. However, this discussion seems to focus mainly on investment, risk or loss perspective, whereas the cost of security operations in IT services is not a published topic (Casaca & Florentino, 2014; Silic & Back, 2014). And while some scholars like Rabbani (2016) propose instruments for estimating alternative costs-benefits for BCM, insurance and outsourcing, no instrument for measuring the cost BCM activities has been observed.

Considering the original research hypothesis and limitations of prior research with little theoretical groundwork available, the case research approach was selected as the basic design of the present study (Yin, 2014; Mills et al., 2021). The single-case research design approach allows for the observation of BCM activities in a contemporary information systems context, the design and operationalization of variables to test the model to determine BCM activity costs in IT (Yin, 2014). The case approach is considered relatively flexible, as it allows a researcher to develop a hypothesis in a contemporary context and choose either a qualitative or quantitative perspective in analysis (Yin, 2014). In both qualitative and quantitative case studies the collection, categorization and analysis is often done by utilizing multiple data sources (Yin, 2014). However while the data sources can be documents, archival records or interviews, observations are normally presented in a numerical format using statistical methods in the quantitative case studies (Benbasat, 1987; Hak & Dul, 2012; Kaplan & Duchon, 1988; Yin, 2014). To be more precise, this research design follows the embedded single-case design as suggested by (Yin, 2009), where the case is BCM and the embedded units of analysis are IT services. With this logic, the population of this study includes any IT service that has a BCM framework integrated into its IT service management practice at any given time. In this case-study, IT service is considered as the main unit of analysis or the case. Focusing on a single case organization can aid access on naturally occurring BCM, IT service and IT cost data, since naturally occurring data were assumed to be a necessity for successful empirical testing. Focusing on a single case organization may also improve the research reliability and validity, e.g., chain of evidence (Yin, 2009).

4.3 Research data

Jenkins (1985) suggested archival research as one of the IS research methods for examining historical documents and Ex Post Facto recorded data. Searching databases of IS research articles, such as the AIS database, suggests that archival research is not necessarily common as a methodology, but it is not uncommon to use archival data, as shown in the following examples by Mithas (2012), Krishnan (2012) and Benaroch (2013). In a traditional sense, archival data has been used for the study of historical documents to learn from past events but is not limited to the historical research only (Ventresca & Mohr, 2017). Today, researchers can have access to digital archival data produced by contemporary organizations in the form of electronic databases, e-mails and internet pages (Ventresca & Mohr, 2017).

According to Moers (2006), ex post data can be classified into two distinct types of archival data, public and proprietary data. Public data is accessible by anyone for any reason, while proprietary data is accessible only if granted by the data owner. Consulting firms, academic institutions and governmental agencies among many other types of organizations may grant access to their research data with limited use terms and often with some form of remuneration (Moers, 2006). According to Moers (2006), the most comprehensive archival data, financial and non-financial can be found by organizations themselves such as company accounting and performance data. It is not unusual that such data has been collected systematically over the years, which makes it possible to have larger samples for statistical testing (Moers, 2006). This so-called hard data can reduce the researcher's bias because the data is generated without the researcher's intervention. In turn, however, the challenge is to find evidence of how the data was generated and manipulated, all of which can affect the reliability and validity of the research (Moers, 2006).

Determining variables can be challenging when empirical data is collected ex post rather than ex ante according to scientific rules, as in this research, where primary data was collected directly from the company's data repositories (Moers, 2006). Since the data is produced without research control, Yin (2014) stresses the importance of ascertaining how archival data was produced and how its accuracy can be verified before it was accessed by the researcher. According to Yin (2014), the opportunity to repeatedly view specific and voluminous archival data or documents may benefit research, but at the same time, research may be subject to selective disclosure of data as well as irregularities due to changes in data and document management practices. To resolve the given risk related to data, Yin (2014) suggests four principles for data collection. The first principle is to use multiple sources of evidence, direct observations, documents, records and to triangulate these findings (Yin, 2014). According to Jick (1979), studying a social phenomenon can improve the accuracy of conclusions by collecting different kinds of data in association with the same phenomenon. As a result, the researcher can develop convergent evidence that can strengthen the construct validity (Yin, 2014). The second principle is to store raw data in a database, which can be much easier with digital data than with physical data (Yin, 2014). The third principle is to maintain a chain of evidence in form of a register of collected data, in order to increase reliability of data (Yin, 2014). The fourth principle refers to the usage of electronic sources, such as social media and other media via the internet, that require special care regarding source reliability and possible limitations on the reuse of the data (Yin, 2014).

The research data was collected from a case company that developed technology services and products globally for both business and consumer markets. In 2013, when the research data was collected, the company was one of the leading companies in its own industry with more than 15 bn/ € annual turnover and nearly 10.000 employees in its IT department at the time of accessing the data. The company was selected for this research for the following four main reasons: First, the company’s IT department had implemented a comprehensive BCM program in 2006, and since then, BCM has been an integral part of the global IT service management framework, enabling the observation of the actual implementation of BCM in IT. Second, the IT organization had an effective financial reporting system for IT services that included both monthly monitoring of IT service and IT cost. This performance data was stored in the company’s reporting systems and continuously monitored by financial controllers and IT quality management, so that the traceability of data sources and the accuracy of data could be considered reliable. Third, despite numerous structural changes such as merging and splitting various global IT teams, renaming IT capabilities to align with the company’s process architecture, decentralizing and centralizing services and introducing new IT technology, the IT service architecture remained the same during the research because it was standardized according to the ITIL framework. As a result, such activities as service level management and performance indicators remained the same in relation to service level targets, thus providing relatively accurate and consistent data. Finally, and most importantly, the researcher had a unique risk management role in the organization, providing access to the research data and overall understanding of the frameworks and activities used. The primary data was downloaded from the accounting system called Service Cost Portfolio Reporting

(SCPR), from IT continuity and IT service management document folders. All archival data and documents collected were naturally occurring data that had not been manipulated by the researcher at the time of collection. The time horizon for all data was from February 2006 to December 2013, from the first BCM report generated by the BCM team to the last date the researcher had access to the data. All documents and data files were downloaded December 2013.

Table 11. The research database.

Data name	Data source	Data type	Sample Time period	Data format	Data files	Description
IT Service Continuity Management Framework	IT continuity management team folder	Qualitative	2012 version	Word	1	BCM process definitions and measurement for continuity planning. (Appendix 1).
IT service continuity management plans	IT continuity plan folder	Qualitative	2013 versions	Word	137	Active IT service continuity plans. (Appendix 2).
IT service continuity maturity reporting	IT continuity management reporting folder	Quantitative-ordinal	2006-2013	Excel	52	Monthly BCM status for each application reported by IT service teams. (Appendix 3).
IT Service level agreements	IT Service level agreement folder	Qualitative	2013 versions	Word	139	IT service level agreements of active IT services. (Appendix 4).
IT Service level agreement	SCPR system	Qualitative	2004-2013	Excel	1	SLA database of all IT applications and services,. (Appendix 5).
IT costs	SCPR system	Quantitative-ratio	2004-2013	CVS.	1	IT cost reports from Service Cost Portfolio Reporting accounting system (SCPR). (Appendix 6).

4.4 Data analysis method

Since the IT services could be split into the two different and comparable groups, standard IT services and elevated IT services with additional BCM, security and compliance efforts, and as the research was based on archival data, the causal-comparative method was seen as the most suitable method for analysis. The assumptions were that the causal-comparative method would allow to observe the BCM cost effect on IT services that perform BCM activities in relation to those that have implemented baseline IT service management activities. The name of causal-comparative analysis implies the establishment of a causal relationship, but this relationship is considered merely suggestive, not proven as in experimental research designs (Johnson, 2001; Salkind, 2010; Silva, 2010). The goal is to determine whether or not the independent variable influenced the dependent variable by comparing two or more groups of entities – in this research, IT services with BCM activities vs. standard services without BCM activities (Salkind, 2010). The figure 5 presents the two groups of IT services – reference and comparison groups. The five independent variables of BCM activities (Equation 4) are grouped into comparison group. The absence of BCM activities in the reference group are presented as a null variable (a_0). In line with the proposed BCM activity cost function $BCM_{Ac}(f) = A(x) + Pr_c(y)(Equation\ 5)$, the figure shows pre-incident costs as dependent variables in each resource cost category discussed in the chapter 3.2 Hypothesizing the BCM activity costs in IT services. The details of each category are discussed in the chapter 4.7.5 cost strata selection variable coding.

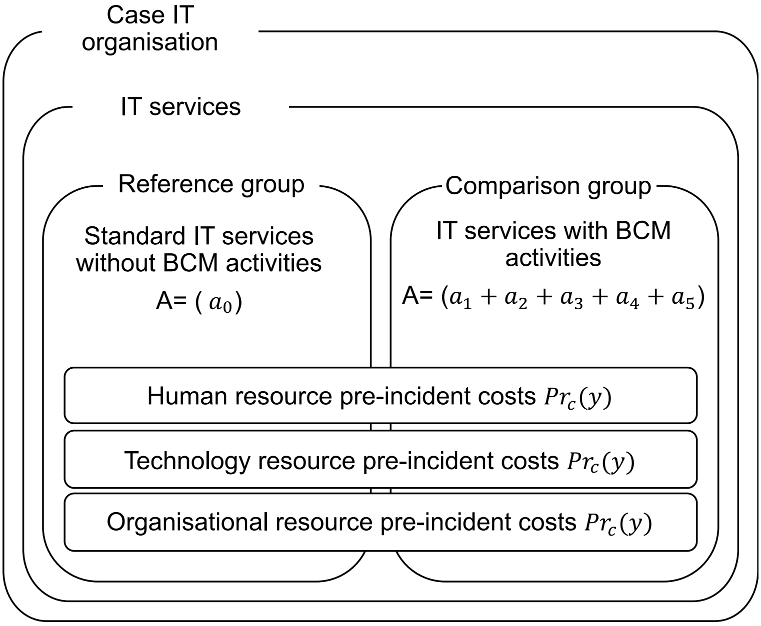

Figure 5. The Causal-comparative research design.

In contrast to experimental research designs, causal-comparative designs examine the relationships between independent and dependent variables after an action or event has already occurred (Ext Post Facto). Since the variables are not manipulated by the researcher, the control of the independent variables is done through statistical analysis rather than control and experimental groups (Salkind, 2010). The lack of direct control of the independent variable and the non-random selection of participants are the major differences between causal-comparative research and experimental research design. Compared to correlational approaches, causal-comparative approach aims to compare differences between two or more groups, whereas correlational approaches intent to identify the variation between two distinct variables (Salkind, 2010). Groups are selected according to already existing categories, i.e., Ex Post Facto and thus they are not randomly assigned (Salkind, 2010; Silva, 2010). Researchers compare differences between groups by using a suitable tool to determine the effect of an independent variable on each group (Salkind, 2010; Silva, 2010).

The original assumption was that the case organization would have used its IT cost accounting system based on activity-based costing (Figure 2). That would have allowed BCM and IT services accounts to be examined in terms of cost, but this was not the case. The case company implemented a management accounting model in which the costs of resources were identified and allocated directly to the cost objects, i.e., cost centers. This would mean that the specific costs of IT processes e.g. BCM activities could not be observed directly as planned (figure 6). This was the main reason that guided the research to use statistical methods to observe cost effect of BCM activities.

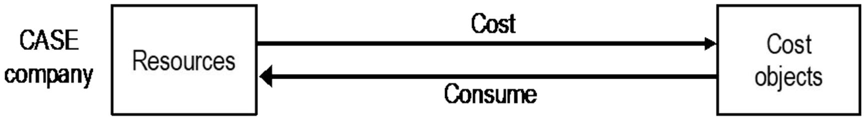

Figure 6. The cost accounting method in the case company.

According to Falta and Wolff (2004), properties of costs can be evaluated according to the principle of stochastic process by treating indirect measurements, for example operating costs, as statistical constructs. Benston (1966) suggested multiple regression to measure non-observable recurring variables, such as IT costs associated with BCM activities. Benston (1966) argued that Multiple Regression Analysis (MRA) could be used to understand cost behaviour whether output may suggest linear or non-linear relation between cost and measured variables. He divided decision problems in a company into two types: recurring problems that are predictable (e.g., optimizing production output) and one-time problems that are not predictable (e.g., creating of a new product). Benston argues that regression analysis is useful in monitoring recurring problems, but reliability depends on how cost-data is collected and maintained. The timeframe should be long enough to allow attribution of cost to output and short enough to capture significant variation among variables. The time horizon of observations needs to be broad, e.g., from period to period, in order to capture the variation in cost and output to measure the relationship. All factors affecting costs should be classified and included in an analysis as well as either adjusted and included to the equation or excluded as ‘bad quality’. Benston (1966) concluded that multiple regression analysis was cost-effective and valuable tool for understanding the cost factors in a situation when the factors are unknown or unobservable, like in this case BCM activities. It can be a mean for a more complete view of reality than a simple linear regression or fixed-variable dichotomy. Successful use of MRA requires continuous, invariant relationship between cost (dependent variable) and the variables on which the cost depends (Benston, 1966). Reflecting upon Benston’s arguments, it was assumed that the correlation between BCM activities and IT costs met the requirement, so multiple regression analysis was chosen as the analysis method (figure 7).

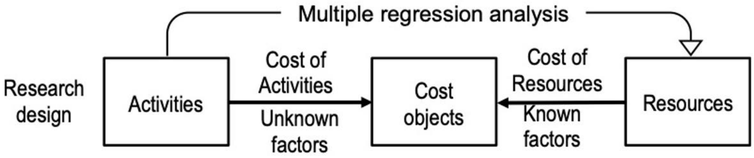

Figure 7. Probabilistic approach on activity cost analysis.

In order to test research hypothesis, the suggested probabilistic approach was translated into the multiple regression analysis equation (Equation 6). It was assumed that the equation would work as a tool, when determining how much of the variation in the dependent variables can be explained by independent variables (Benston, 1966; Field, 2013; Hair, 2010; Tabachnick & Fidell, 2014).

Equation 6. Multiple regression analysis.

$$Y = \beta_0 X_0 + \beta_1 X_1 + \cdots \beta_n X_n + \epsilon$$

$Y = : Pre - incident\ IT\ service\ costs$
$\beta_0 X_0 = The\ coefficients\ of\ IT\ service\ costs\ when\ X = 0$
$\beta_n X_n = The\ coefficients\ of\ IT\ service\ costs\ when\ X > 0$
$\epsilon = The\ random\ error\ of\ observations\ not\ measured\ by\ the\ model$

Multiple regression analysis supports testing one dependent variable measured at continuous level and two or more independent variables measured at least at nominal level, as in our case, where the dependent variable is cost data and the independent variables were coded into binary dummy variables. In a multiple regression analysis, the statistical significance informs if a null hypothesis can be rejected, whereas the practical significance informs the effect size of an independent variable on dependent variable when comparing IT services with and without BCM activities. We used these statistical functions to observe how much variation BCM activities caused in different cost categories (strata) in order to confirm if the cost of BCM activities can be determined with the given variables and method.

4.5 Data selection and preparation

4.5.1 Data selection

Before data preparation, IT services for the research were reviewed and selected by the criteria that would reduce risk of data quality issue later in the testing phase. The definition for what was considered as an IT service was based on the case IT organization definitions as described below:

1. a service is provided to one or more customers by an IT Service
2. an IT Service is based on the use of information technology and supports the customers' business processes
3. an IT Service is made up from a combination of people, processes and technology and should be defined in a service level agreement
4. an IT service core functionality is based on application(s) that can be dedicated for a single service or multiple services (shared service)
5. an application runs on one or more servers or clients

Considering the case organization IT service management definitions described above, three criteria of inclusions were determined for the selection for which applications were included in the comparative groups. The first criterion required the inclusion of IT services with service level agreement (SLA) to ensure the connection with BCM activities. The second criterion was the inclusion of IT services for which cost data were available for at least one year to ensure the availability of complete and comparable data over the IT service lifecycle. The third requirement was the inclusion of IT services that directly serve business processes. The reason for business process perspective was due to the case organization accounting model. The case organization classified IT services into four applications classes based on the functional purpose of an application: business applications, infrastructure applications, IT internal applications and platforms. The case company cost management accounted business applications as a directly assigned costs, while all the other application types and platforms were accounted as a shared cost. As discussed, later in the chapter 4.7.4 cost dependent variable coding, only directly assigned costs could traced back to each IT service, including BCM activities by each IT service. Because of the different cost assigning models, there was the risk of skewed results in hypothesis testing. Assuming that all three inclusion criteria were met, no discontinued or retired IT service was excluded from the grouping. All IT services that did not meet any of the three inclusion criteria were excluded from the groups. During the process 526 applications out of 1344 applications met all selection criteria, predominately business applications. The final sample sizes, 268, were affected by 1) data cleansing 2) strata selections and 3) manipulation of influential values for statistical testing discussed later chapters.

Table 12. Applications reported by the case organization.

Applications 2004 - 2013	Frequency	Percent	Valid Percent	Cumulative Percent
Applications without SLA	400	29.8 %	29.8 %	29.8 %
Business applications	526	39.1 %	39.1 %	68.9 %
Infrastructure applications	418	31.1 %	31.1 %	10.0 %
Total	1344	100 %	100.0%	

All BCM, cost and application SLA archival data were downloaded directly from the reporting systems and stored into the case research database – each on its own excel file. 1) BCM data was available for the years 2006 – 2013. 2) Cost data was available for the years 2004 - 2013. 3) IT service level data was a list of all services, applications and their SLO attributes since 2004. Sensitive data was erased from all datasets including names of commercial products, in-house system names, locations, business processes and names systems of owners and managers. The data cleaning for each data class consisted of removing and correction of inaccurate, incomplete, and incorrect data that could lead on systemic errors in testing (Salkind, 2010b).

During the coding process specific attention was given to two key variables – work effort number (WE) and month of reporting. WE number was the unique identifier that was used to associate cost events the cost objects like projects, programs, units, and applications. WE number was also used as key identifier in tracking BCM activity status per application. WE number allowed bundling of cost data with BCM data that was associated to each application. However, use of WE number would not enable distinguishing of individual BCM activities reported periodically for each application in the scope of the BCM program. To resolve problem of data merging, a new unique identifier (UID) was coded by combining WE number and the date of reporting. The syntax of the new UID was: WE number + year + month. While all three data types, BCM, cost and application SLA data were in separate datasets, the new UID allowed merging of datasets from three separate datasets into a single SPSS data file. Merging was done by using SPSS function "merge one to many", resulting that each unique cost event was associated with corresponding BCM activity event and applications' service level objectives. As a result, the data file contained three types of IT services, 1) IT services with costs only 2) IT services with costs and SLA details, and 3) IT services with cost and SLA details and BCM activities/status. Type 1 cases were removed as they did not bring information on causal-comparative analysis. Cases type 2 operated as a reference group data and cases type 3 operated as a comparison data.

Case company reported BCM activities by using categorical numbering 1 to 5 (appendix 3) on a monthly basis, where 1 one indicated early phase of BCM maturity, completing all five activities marked mature BCM of IT service and reported as 5. Before the maturity could have been updated from one phase to next one, all defined activities had to be fulfilled according to pre-determined criteria and validated by the BCM subject matter experts. If IT service team did not have any changes in BCM activities, the reported maturity status remained same as the latest reported status. BCM team reassessed each IT services' continuity planning status monthly. IT services were required to provide, at least annually, evidence of BCM tests and exercises, to maintain level 5 maturity status, otherwise the status was reduced to the level whose criteria best matched the current situation. The Table 13 is an example how activities were reported annually by IT services. In this two year example, IT service team completed an application IT continuity and risk analysis reaching the first level of maturity (1) in March (year 1). On May, the team completed IT continuity strategy design and got business approval (2) to continue with implementation (3). As the example demonstrates, the maturity level (3) remained same from July till December, 6 months, indicating the length of implementation. During January (year 2) Team members and key users were trained to use the plan and technology, and plan was communicated (4). Continuity test was completed by March; thus, the maintenance phase was achieved (5). The status remained same, till June in Year 2, when the status dropped from level 5 to 3. The drop was due application version management, which required implementation of new IT continuity solution (3) a new backup. The team reached the level (5) in October after successful backup testing. Because the application lifecycle was ending on December (year 2) the BCM status was reported as 0.

Table 13. Example of the BCM maturity two years reporting for an application.

	Year 1												Year 2											
Months	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Phase	0	0	1	1	2	2	3	3	3	3	3	3	4	4	5	5	5	5	3	3	4	5	5	0

The BCM data was maintained and updated by the BCM team in IT organization. IT service managers were responsible to report monthly the maturity of BCM activities per each application, hosted by the IT service teams. Updated status data recorded into a spreadsheet (Microsoft Excel) and stored into BCM reports folder in fileserver, accessible only by the members of BCM team. Each month a new copy of BCM record was created from the prior month template and updated with latest status information. Since February 2006 till December 2013, a total of 95 monthly files were created for BCM reporting purposes. Each report consisted of BCM information of all classified applications that were on production during the time of reporting. BCM reports excluded all applications that were considered as non-critical and those that were either on initial development, sunset phase or ramped-downed.

The case company developed its operational capacity in all functional areas such as R&D, general management, and manufacturing continuously. To respond to business needs, IT department developed new systems and enlarged the global reach of IT services. Therefore, IT services and applications were subject for constant change. Due to this the number of applications in production varied month-to-month. In practice, this means that in any given point in time, there were hundreds of applications in different lifecycles. The application lifecycle could vary from months to years, depending on how critical the application was for the processes, technological development, and cost efficiency needs. From BCM point of view, IT service team could start BCM activities to a new application, but would not complete all activities, as the application was terminated on very short notice. The unceasing changes on applications was the reason for taking statistical perspective on analysis instead of doing case analysis on each application separately. The scope of BCM remained unchanged from February 2006 till May 2008 because of the client-server architecture, but in mid-2008, the new Service Oriented Architecture boosted the increase of application volumes. In late 2012 system architecture started to undergo major changes that effected 2013 and beyond when the case company set new ambition to transfer applications to the cloud services. During the BCM data examination, 2013 BCM data consisted of dozens of applications that were on production in legacy model and in cloud environments model. Because of contradictions and overlaps in application reporting, 2013 BCM data was excluded from this research. The Table 14 shows the number of all applications in the IT department scope of BCM between 2006 till 2012. Out of all applications, 268 were included in the scope of this research based on the criteria discussed later in next chapters.

Table 14. Applications with BCM implementations 2006–2012.

	2006	2007	2008	2009	2010	2011	2012
In scope	74	74	97	127	137	146	156
Not in scope	70	95	103	157	192	218	254
Total	144	169	200	284	329	364	410

4.5.2 Data preparation

For the research purposes, the BCM data was uploaded from Excel file to the SPSS file. BCM data entry reports were arranged by application WE code into a chronological order starting from 2006. The first goal of the quality review was to identify existing pattern of the ordinal numbers from 1 to 5. It was assumed that the transition of the numerical value from 1 to 4 would demonstrate the practical implementation of BCM in phases. Missing values were added based on the pattern of observation e.g. 1111_1111 would add 1 (Hair, 2010). As an example, if a service had BCM activity status 1 from January to April, then no status on May and again status 1 from June to September, then the status in May was corrected as 1. Following the same logic, if monthly BCM activity data series had abnormal value e.g. 4441444, the number 1 was replaced with the observed pattern value, in this case 4. Missing values between different entry values, e.g., 1111_2222, were rounded down. Duplications were detected by comparing the reporting date of BCM entry, the BCM activity number and application WE code. All unclear cases were removed. If an application had less than one year of BCM entries, application was excluded from the sample. While the sampling data can be considered as time series data, in this research all strata were treated as a single time independent data sample to ensure independence of observations in multiple regression analysis (Benston, 1966).

Since 2006 till to the date when data was exported to the use of this research, the model was unchanged, therefore all applications, reported by the IT services, were measured with the same consistent model. A total of 7861 BCM data entries were included into the sample from this time period (Table 15). Reflecting the frequency distribution of BCM activities, it can be evidenced that more than half of the reported activities were BCM maintenance activity type. This result was suggesting that the BCM process was not a fully cyclical plan-do-check-act process used e.g. in ISO 22301:2019 (International Organization for Standardization, 2019) but more like plan-do-check-act-check-act cycle with continuous validation by checking and then acting, without returning the plan-do phases. Instead of full cycle, the development phase considered first four phases, which after the maintenance phase were reported as a “status quo” unless annual testing and exercises were postponed. In this case IT service reported phase 4 (embedding activity) instead of phase 5 (maintenance activity). This reporting approach explains why the embedding activity had the second highest data point frequency. If the service was the subject for a major change that would require change of business continuity solutions too, IT service reported the corresponding BCM activity.

Table 15. BCM datapoints by activity types.

BCM datapoints by activity types 2006-2012	Frequency	Percent	Valid Percent	Cumulative Percent
BCM_analysing_activity	595	8 %	8 %	8 %
BCM_designing_activity	221	3 %	3 %	10 %
BCM_implementing_activity	941	12 %	12 %	22 %
BCM_embedding_activity	1624	21 %	21 %	43 %
BCM_maintenance_activity	4480	57 %	57 %	100 %
Total	7861	100 %	100 %	

The 7861 BCM data points were combined with the IT cost and service data using ‘one to many’ technique where one data point is combined to many corresponding data points. This was done by using three key variables 1) Work Effort numbers 2) application name and 3) reporting period. Combination was done by using SPSS one-to-many function where one observation in one file may have multiple matching records in another file. In the first combination round, all BCM data points were merged with all the cost data. Since for any application there could be N+1 cost cases in the dataset for every month, and only one entry for BCM activity, the number of BCM activity entries multiplied to the same number as there were cost events. During the quality review, 2.7% of BCM activity data points were duplicated. Thus each case was reviewed and valid duplicates removed from the dataset. Consequently, the result of one-to-many combination processes was that the 7861 unique data points were multiplied to the 90557 data points.

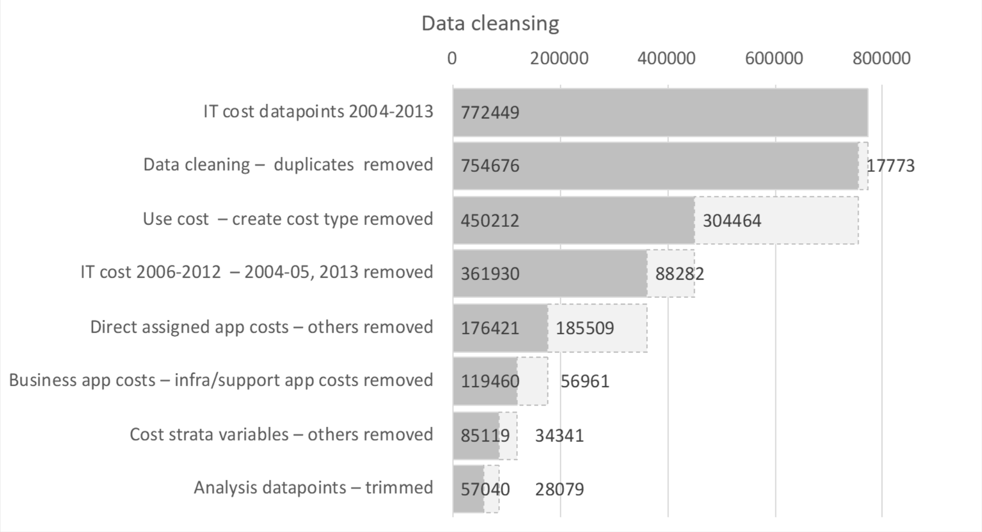

Figure 8. Data cleansing by phases.

After combining all data points into the single dataset that incorporated all IT cost, IT service and BCM data, a new cleaning process started before the creation of sample stratum. The first cleaning considered removing all cases that were not associated to the operative applications. Such application data entries were kept in the record for accounting or IT service portfolio management reasons. As an example, application development was ended before going live or an application was ramped down soon after release. In both cases they were recorded into the service reporting system. The new dataset contained total of 772449 data points from years 2004-2013. This dataset was stored as a backup before next modifications.

As a result of the new data quality review, 17773 duplicates were removed reducing the dataset to 754676 data points. Total of 304464 create-cost type data points were removed as none of those were associated with the IT service costs. Instead, they were larger IT change cost types. As discussed earlier, both technological and organizational changes affected also the BCM activities, and therefore sample time horizon data points from 2004–2005 and 2013 were excluded so that the 361930 data points between 2006–2012 remained. 185509 data points that indicated indirect cost association with the applications were removed, leaving 176421 data points that were directly associated with the application costs. The final cleaning removed all unclassified data points that could not be associated with any of the cost strata variables. The sample before removal of outliers and sampling by cost strata was 85119 data points.

According to Allen (2017), social sciences researchers can face challenges with dataset outliers. Because the mean values in statistical testing, e.g., multiple regression analysis, are sensitive to the extreme high values, i.e., outliers, researcher needs to eliminate the influence without compromising the whole dataset (Allen, 2017). This challenge can be resolved by different approaches, e.g., winsorizing that is transforming the influential values to fit on distribution within the sample or trimming that is removal of the outliers from the sample (Allen, 2017). This research experienced the issue with outliers as described by Allen (2017) as cost data point values could have extreme values. Furthermore, data review did not show any specific pattern or factor that could be manipulated without affecting a significant portion of the data. Using either winsorizing or data trimming would have reduced strata data points proportions significantly. The unmodified data also suffered from positive kurtosis and skewness, so the first resolution was a log transformation of the cost data (Field, 2013). Log transformation resolved issue with positive kurtosis and skewness and while the number of outliers was reduced, there were still outliers that required action. The remaining issue was resolved by trimming remaining outliers from each stratum by using box-blot that help visually to handpick, review and remove outliers case by case (Field, 2013). Despite these actions, ~34% of data points were excluded, leaving 57040 data points for testing the strata.

After the data cleansing process, the total of 268 applications from 2006 to 2012 remained in the sample, which can be seen from the Table 16 that presents the impact of the data cleaning on the number of the applications included in the research. As discussed earlier, the case organization's IT services could be classified into the two groups – standard IT services and critical IT services. The standard IT services had a lower-level SLA, e.g., backup and availability systems were in place but with longer response times and lack of coordinated BCM. The critical IT services had a high SLA targets like high availability, incident response capability as well as BCM alongside with other coordinated ITIL processes.

Table 16. Distribution of the applications by strata.

Stratum	Applications	Reference group– no BCM	Comparison group – BCM	Accounted in both groups during lifecycle
1. All IT service costs	268	267	100	99
2. Internal work costs	246	244	100	98
3. External work costs	252	246	95	89
4. Software purchasing costs	132	125	58	51
5. Software maintenance costs	119	115	57	53
6. Hardware purchasing costs	109	100	48	39
7. Hardware maintenance costs	101	99	42	40
8. Internal service provider costs	63	63	26	26
9. External service provider costs	187	186	60	59
10. Internally owned application costs	212	211	91	90
11. Externally owned application costs	37	37	37	37
12. Proprietary customised application costs	101	101	40	40
13. Commercial customized application costs	75	75	35	35
14. Commercial configured application costs	38	37	9	8
15. Regional service delivery costs	37	37	15	15
16. Global service delivery costs	212	212	85	85

Considering this perspective, one can see that the number of applications in the scope of research were not distributed equally between strata or by reference and comparison groups. Instead Table 16 shows how the number applications vary between stratum and by groups. The asymmetric distribution of applications by cost stratum could be explained by the dynamic lifecycle of an application. An application could be originally in-house developed but over the lifecycle the application design has changed because of business needs, from local to globally used application. Over the lifecycle, both internal and external parties had been part of development costs and at some point, the application has been outsourced as a part of IT service optimization. This also explains the reasons why the sum of reference group applications without BCM and comparison group applications with BCM is more than applications per stratum. As an example, all IT service cost strata, 99 of applications out of 268 have been at some point of the lifecycle in both reference and comparison groups. This can be explained as an application may have been in standard SLA on early phase of the lifecycle, but when business has been developed, the increased importance drove it to change from a standard to a critical application, and therefore also in the scope of the case company BCM program. Because of the dynamic lifecycle of an application, cost factors were also subject to change overtime, thus the time series dataset was analysed as a pooled dataset.

4.6 Data sampling approach

Sampling is the process of selecting a subset or sample unit from a larger group or population of interest to address the research question (Collins, 2010). A population can be defined as including all tangible or intangible research subjects over time, e.g., all technology companies from 2000 to 2021, all information systems researchers in 2021, or the superpopulation of internet users (Collins, 2010; Lavrakas, 2008). One of the most fundamental considerations affecting the sample and population is the identification of the primary unit of analysis, as this can have implications for the generalization of results from one case to another (Keller, 2010). In social science, the unit of analysis can range from individuals, groups and organizations to the abstract social artefacts and interactions, such as processes or, as in this case, the IT services (Kumar, 2018).

As discussed in earlier chapters, BCM activities are suggested as a performative aspect of organizational routines (Pentland & Feldman, 2005), so the level of analysis occurs at the level of social artefacts, that is BCM. The unit of analysis in this research is the IT service in which context five sequentially definable BCM activities can be observed. The unit of sampling was determined by four perspectives in our hypothesis, which were merged with theoretically proposed IT cost types, e.g., Irani (2006).

Table 17. Research units defined.

Level of analysis	Units of analysis	Units of observation	Units of sampling
Social artefact – BCM	IT service (application)	BCM activities	Cost types

Consistent with the hypothesis and the use of archival data, the stratified purposeful sampling frame was chosen as the sampling scheme (Daniel, 2020). The access to complete archival data containing several years of lifecycle cost details for all IT services and BCM activities allowed us to design a sampling frame specifically associated with each of our hypotheses. The purposive sampling requires that a specific criterion has been established by the researcher to select participants for sampling (Daniel, 2020). Criterion may be based on the average or rareness of certain features, characteristics, an assessment of the need for a specific unit or the theoretical relevance of a unit, or, as in this research, various IT cost types (Daniel, 2020). Stratified purposive sampling may limit generalization beyond the unit of analysis and the observations included in a sample. However, it allows the inclusion of units that are valuable to the theory of interest, in this case BCM costs in IT services (Daniel, 2020). During the sampling process, the IT costs were divided into mutually exclusive but at some level homogenous and separate subgroups or strata according to predefined categories presented in the sampling strata table 18. According to Given (2012), the selected sampling frame could reduce the risk of over- or underrepresented observations and allow for a systematic comparison based on the predefined categories derived from the theories and frameworks.

The timeframe for the observations was determined by the sequential and time-dependent distribution of BCM activities in the target organization. Since the implementation of BCM activities was subject of the settings of each IT service, the time horizon chosen for the sampling units of observations was the entire lifecycle of an IT service, ranging from months to several years. The first BCM activities started in 2006 in the case organization and the last archival download was in 2013. While the intention was to include all BCM activity reports, the data quality screening showed incomplete data in 2013. For this reason, the research includes cost events and BCM activity reports from 2006 to 2012. While the sampling data can be considered time series data, in this research all strata are treated as a single time-independent data sample to ensure independence of observations in the multiple regression analysis (Benston, 1966).

Table 18. Sampling strata table.

Hypothesis	Cost category	Strata
H1	IT service cost	1. All IT service costs
H2	Human resource cost	2. Internal work costs 3. External work costs
H3	Technology resource cost	4. Software purchasing costs 5. Software maintenance costs 6. Hardware purchasing costs 7. Hardware maintenance costs
H4	Organizational resource cost	8. Internal service provider costs 9. External service provider costs
H5	IT service design cost	10. Internally owned application costs 11. Externally owned application costs 12. Proprietary customised application costs 13. Commercial customized application costs 14. Commercial configured application costs 15. Regional service delivery costs 16. Global service delivery costs

4.7 Operationalization

4.7.1 Pattern matching

In this research, the pattern matching technique has been used to operationalize independent variables based on the theoretical realm discussed in the above chapter and the empirical realm in the case organization (Sinkovics, 2020). According to Trochim (1989), theories can be used to postulate structural relationships between key constructs and thus patterns of expectations. In this context, a pattern can be characterized as any non-random construct of objects or entities (Mills et al., 2021). Fundamentally, pattern matching is about comparing a predicted theoretical pattern with an observed empirical pattern and trying to combine these two patterns into one representation of reality (Trochim, 1989).

The theoretical cost of the BCM activity model in chapter 2.1 was compared with the BCM framework implemented in the target organization's IT service management systems. First, a cross-reference matrix was created based on the Table 1 BCM activity and task list. In the next phase, the organization's BCM framework document called "IT service continuity management framework", version 2013, was examined. The document was the IT department guideline for all IT services and operations within the target organization for the implementation of BCM in IT services. Theoretical BCM activities and tasks (Table 1) were compared to each requirement defined in the organization's BCM framework (Appendix 1). To confirm the implementation of the "IT service continuity management framework", 137 active IT service continuity plans (Appendixes 2 and 3) were reviewed. The second purpose of the pattern matching analysis was to observe how BCM was integrated into the IT service management framework by comparing the theoretical IT service management framework discussed in the chapter 2.3 with the actual implementation of the target organization (Appendixes 4 and 5). The final purpose of the pattern matching analysis was to compare similarities between the theoretical IT cost types (Table 4) and the cost types used by the target organization empirical cost data downloaded from the Service Cost Portfolio Reporting tool for comparison (Appendix 6). All observations were collected into three cross-reference tables for comparison (7, 8 and 9). Observations between theoretical and empirical activities were operationalized and coded for statistical testing.

Table 19. Pattern matching between theory and empirical observation.

Theoretical realm	Empirical realm	Use in the research
BCM activities (chapter 2.2)	IT Service Continuity Management Framework IT service continuity management plans	Independent variable operationalization
IT service management (chapter 2.3)	IT Service level agreements IT service cost portfolio reporting accounting system	Control variable operationalization
IT costs (chapter 2.4)	IT service level agreements IT service cost portfolio reporting accounting system	Dependent variable operationalization

4.7.2 BCM independent variables coding

Maturity Models (MM) are suggested as approach to drive process improvements (e.g., Becker 2009; Aho 2009; Pöppelbuss 2011; Randeree 2012; Röglinger 2012). Therefore, organizations use these models to speed up the development of management activities as did the case organization. In 2006, the BCM team of the case organization developed a maturity model of measuring the progress of the BCM implementation. The MM was applying principles from the standard BS 25999-1 Business Continuity Management Code of practice, developed by the British Standardizing Institute and from the Capability Maturity Model, introduced by the Software Engineering Institute. This internally developed Prescriptive Model (PM) (Becker et al., 2009) introduced a roadmap for IT services on how BCM can be applied in IT service management. The PM consists of a set of objectives or, more specifically, explicit success criteria, and was used to measure readiness for each BCM activity within IT services. The model included 5 BCM activities reported monthly by categorically numbering 1 through 5. Completion of all five activities was marked as mature BCM of IT service and reported as a 5, whereas 0 or blank fields in the reports indicated that the IT service was not in the scope of BCM. The case organization classified IT services (IS applications) into critical and non-critical services. If an IT service was listed as critical for business, elevated service level was required, including BCM. Non-critical IT services were managed by standard service levels that ensured basic backup and incident response capacity but were not extended to the same level as critical services. From a quantitative method perspective, this classification allowed the use of causal-comparative design (Salkind, 2010) which is discussed later in the chapter on methods of analysis.

Table 20 compares the theoretical BCM activity variables and the empirical variables from the case organization. In the empirical variables, the activity type 'establishment of the program' was not measured for IT services, because it was perceived as a general activity by the BCM team. This observation supports the suggestion by Boehmer (2009) that while a business continuity management system (BCMS) has its place in a management system, the survivability of an organization depends on the specific activities to develop, implement and maintain continuity capability. Based on the empirical variables and the BCM activity cost concept, the 'establishment of the program' activity was excluded from the operationalized variables of BCM. The naming syntax for the variables contains two fixed terms, BCM and Activity. The descriptive components were defined by the most dominant tasks described within theoretical and empirical models. Although the definitions given may imply the exclusion of other tasks, each variable directly denotes the theoretical activity model. For quantitative analysis, variables were coded into dummy variables and original categorical values (1-5) were replaced by binary values (Benston, 1966; Field, 2013). This coding can be seen from the appendix 10.

Table 20. Operationalisation of the BMC activity variables.

Theoretical variables	**Empirical variables**	**Operationalization variables**
Establish the program	Not defined	Excluded
Understand the organization	Level 1: Complete IT Continuity risk and impact analysis	BCM_analysing_activity (X_1)
Determine the business continuity strategy	Level 2: Complete IT Continuity management strategy development and business approval	BCM_designing_activity (X_2)
Develop and implement the plan	Level 3: Complete IT Continuity strategy deployment and plan delivery	BCM_implementing_activity (X_3)
Embedded business continuity into organization	Level 4: Complete IT Continuity plan communication and training	BCM_embedding_activity (X_4)
Exercise, test and maintain the plan	Level 5: Maintain & exercise IT Continuity Plan	BCM_maintenance_activity (X_5)

4.7.3 SLA control variables coding

In order to determine whether BCM activities have difference in IT service costs, we have to compare IT services with and without BCM activities. Besides comparisons between two groups by independent variables, additional control variables can enhance this comparison. The term control variable refers to variables that are not of primary interest for the research but are used to reduce bias in the analysis of the independent variables (Salkind, 2010b). As an example, comparison between two models, one with the control variables and the other with both independent and control variables, can uncover if adding an independent variable into the model has any observable effect on dependent variable taking into account other similar factors (Tabachnick & Fidell, 2014; Field, 2013).

In this research, two control variable types 1) Information security and 2) compliance derived from the case company IT service management model, are used for additional observation of the effect change of BCM activities. If we can observe BCM activity variables effect size differences between baseline model with only control variables and the model with both control and BCM variables, it can confirm that the main model measures BCM activity costs as proposed. In other words, adding BCM activity variables into the baseline model can show the cost effect of BCM on IT service (Neuman et al., 2004; Dedene et al., 2008). If we cannot observe any differences when adding the BCM activity variables into the model, we may conclude that there are no practical significance of measuring BCM activities, thus the proposed construct does not provide value for future research or practical applications.

Theoretically speaking, as IT service continuity is one of IT service management activity types cf.. Johnson (2007) and Cater-Steel (2006), BCM activities can be considered as an equal cost factor with other IT service management activities. Because the case organization IT service continuity management expectations were communicated in IT service level agreements, for the business-critical IT services, it can be suggested to use SLA requirements as control variables. The case organization had implemented an IT Service management system (Appendix 4) comparable with ITIL activities as discussed by, e.g., Cater-Steel (2006) and Marrone (2017). In the framework, each IT service had own SLA that was agreed and monitored with all the business units and processes that use the IT service to ensure that the highest service requirements were the leading factors in SLAs. The SLA requirements included business specific requirements reviewed and accepted by user organisations.

The business specific requirements considered information security and compliance requirements from the end-user organizations that each IT services needed to design and implement as well as IT service continuity documentation. The information security consists of two main areas 1) data security classification (DS) and 2) system security classification (SS). The data security variable stated four data sensitivity classes – secret, confidential, internal, and public data. Because the security measures for secret and confidential data would require similar type of elevated controls, such like two-factor authentications and encryptions in databases, IT services that processed sensitive data, could be compared to the reference group IT services that would require standard level data protection. Therefore, four data security classes were organised into two classes – elevated (secret, confidential) and standard (internal, public) data security classes, whereas elevated class had dummy variable coding for one (1) and the standard with zero (0) coding.

While the data security classification considered the information and data confidentiality, the system security classification defined the security requirements for threats that could cause integrity and availability incidents. System security objectives were defined either baseline or special. Special classification would mean that the IT services would need to implement added security controls that would account the context of the service, such like two-factor secure internet authentication or system admin logging automations. Additional security controls were used for any system that could have high impact on the case organization business operations. System security classes were coded into the dummy variables elevated (1) and standard (0).

Both data security classification (DS) and system security classification (SS) were merged into the single control variable – SLA security class. In practice DS and SS elevated dummy variables formed the one group with shared binary value 1. DS and SS standard classes formed the other group with shared binary value 0. The purpose of merging was to provide single security control variable, that would measure the cost variance caused by adding elevated level security on standard level security. The coding, elevated (1), reflects the added security efforts on standard IT service comparing the standard (0) security efforts. It can be assumed IT services with elevated security requirements have higher costs than IT services with standard security classification, similar fashion like BCM activities between different IT services.

As discussed earlier, the business specific requirements had two classes. The second compliance class also held four different regulatory requirements 1) privacy compliance 2) trade compliance 3) software compliance, and 4) finance compliance. Depending on the business needs an IT service could be subject to all four types of regulatory requirements or none. Each of the requirements had two to four sub-classifications that would require distinctive design for the IT service, therefore such IT service could not be characterized as a standard IT service. Considering this, each regulatory requirement type's sub-classifications were operationalized into the elevated (any compliance required) compliance class with dummy variable value one (1) and the standard (no compliance required) class zero (0) dummy variable. Considering literature, it appears that compliance management is not a formal IT service management processes area, but compliance issues are addressed in some ITIL processes like in information security management (Iden & Eikebrokk, 2014) or regulatory and compliance testing is listed as a type of test to be performed to verify that the service meets the end-user requirements (Sahibudin et al., 2008; Gallacher & Morris, 2012; Agutter, 2019). Although information security management considers regulatory compliance as one of the key areas, this research regards compliance requirement as an own theoretical type of variables (Calder, 2015). For the quantitative analysis, all control variables were coded into dummy variables and the categorical values were replaced with binary values (Benston, 1966; Field, 2013). This coding can be seen from in the appendix 11.

Table 21. Operationalisation of the control variables.

Theoretical SLA variables	Empirical variables	Operationalization variables
Information security management	Data security	SLA_security_class (X_6)
	System security	
Compliance management	Privacy compliance	SLA_compliance_class (X_7)
	Trade compliance	
	Software compliance	
	Finance compliance	

Considering the IT service level requirements, they were organized to reflect ITIL management processes, such as incident and service request resolution time, system availability targets, application performance targets and system recovery time objectives (Johnson et al., 2007; Gallacher & Morris, 2012; Iden & Eikebrokk, 2014). Service classes were expressed in terms of platinum, gold, silver, bronze, and steel service levels within the SLA. While some groups of IT services share the same service classification, the performance requirements could differ significantly within the same service level class, thus none of the classes could be handled as a distinctive control variable. It was also noted that service classes were correlating highly with independent variables causing “multicollinearity” problem thus weakening the statistical significance of independent variables. For these reasons and for the fact that during the statistical testing, service classes do not comply statistical significance requirements, service levels were not suitable control variables for independent variables.

4.7.4 Cost dependent variables coding

The research is based on the hypothesis that assumes a correlation between BCM activities and IT costs. Therefore, cost is the dependent variable. The cost data used in this research is naturally occurring data from the case organization service cost portfolio reporting system. The data is treated as a continuous variable due to its data format – integer and currency. Because of this, dependent variable is not coded to the other type of variable. Since the influence of dispersed data was large, the original integers were transformed to log format to reduce the effect of outliers and to conform with normality assumptions in the analysis (Field, 2013). Because the last data point was observed in 2013, cost data has already been outdated considering how human, technology and organizational resource costs have been assumably changed over years. Since the primary goal of this research has been to test the research hypotheses with actual data to understand the BCM activity cost effect between the reference and the comparison groups, outdated cost data creates no problems.

Cost data was recorded and reported by financial controllers of the IT organization. IT costs were divided into two main categories – Create costs and Use costs. Costs of substantial information system and organizational change programs, such as outsourcing partner changes or data center ramp have been included in the Create costs category. Although such programs had an impact on IT services, the impact was considered as a shared cost type and was not specifically attributed to the management process, e.g., BCM activities. Because of this, all the Create costs data were excluded from the research. Use cost data had two categories – assigned costs and directly assigned costs. The assigned cost category grouped shared cost factors, such as data center costs, network costs and common platforms like access management costs. Shared costs were charged equally by IT services; thus, the effect of service-specific activities was not included in the assigned cost category. Consequently, shared costs were excluded from hypothesis testing. Direct allocated costs were cost factors that were directly attributable to each application within IT services, such as initial and ongoing costs over the lifecycle of an application. This specific cost data was included in the hypothesis testing in its original form.

4.7.5 Cost strata selection variables coding

Next sections introduce the cost classifications developed and used by the case organization and mainly used for testing the proposed hypotheses. Classifications were used as a selection variable to take purposeful sample from the whole IT cost data to test especially hypothesis H2 – H5 as the H1 accounted all cost types. The classification is based on the observations how the case organization had adopted commonly used cost classifications, e.g., hardware and software maintenance cost classes or outsourcing cost types (Appendix 9).

Hypothesis 2 was focused on the relationship between human resources of BCM and costs. There were several costs related to human resources. The internal work costs classification (INT) encompassed salaries, incentives, and overtime compensation for all full-time and part-time internal employees. External work costs (EXT), sub-contracting (SUB) and outsourcing (OUT) included all costs charged to any external individual or organization. Because all external cost types (EXT, OUT, SUB) referred to non-internal work cost they were merged into the single coded variable external work costs (EXT) distinction from the internal work costs (INT). Considering the relation with proposed total cost of BCM (Table 9), human resource cost type could take place during pre-incident or post-incident phases. Because the goal of this research is to measure the correlation between specific BCM activities described in the literature (Table 1), human resource cost types would consider BCM analysis, design, implementation, awareness and maintenance work conducted by the IT service teams and the BCM subject matter experts. If there was BCM related incident data, in theory the model could consider measurement of post-incident work costs too. Due to lack of this data, this sampling cannot be done in this research. This limitation applies to other cost factors as well, as this distinction could not have been made with the available data.

Hypothesis 3 was focused on the relationship between technological resources of BCM and costs. There were several costs related to technological resources. The cost of software acquisition (SW) takes into account the cost of acquiring licenses, source code and specific tools for programming and release. Software maintenance costs (SWM) take into account ongoing costs such as annual charges and license fees for use, version updates and intellectual property rights, e.g., right to customization. The case company classified hardware purchasing cost class (HW) so that it would cover costs caused by procurement of application-specific hardware and tools for the configuration of hardware, that were needed in the initial phase of IT service building. Hardware maintenance costs (HWM) consider changes and upgrades of components and related tools as well replacement of faulty parts during the IT service operations. None of the above classifications included any reference to specific activity-based costing classes, e.g., continuity, security or availability activities. Although the classifications were relatively high-level views comparing all possible IT cost types, they allowed selective sampling to measure and test specific hypothesis about human resource costs and technology resource costs. These empirical classifications were operationalized as SV_accounting_cost_type, to denote that these were classified by the IT accounting of the case organization.

Hypothesis 4 was focused on the relationship between organizational resources of BCM and costs. Unlike human resource and technology costs that were explicitly classified in the accounting system, hypothesized organizational resource and IT service design costs were not classified. To resolve missing classification for sampling and testing, new classifications were developed based on the case organization IT service level properties stored into service costs and portfolio management system. For organizational resource cost hypothesis testing, two variables were created – internal service provider costs and external service provider costs. Case organization classified applications in each IT service by the service provider. IT service provider denoted the organization that was responsible for developing and/ or maintaining the service. Four IT service providers were recorded in the system – internal IT organization and three external organizations. In the operationalization model, original coding of external IT service organizations was merged into the single variable – external IT service provider costs. These were operationalized as a SV_service_provider_cost_type. The variable was used as a selection variable to take purposeful sample from the whole IT cost data to test hypothesis H4.

The third research question assumed correlation between BCM activity costs and IT service designs. Three design factors were included into the hypothesis H5: application ownership (Chen et al., 2017), application customization (Cox et al., 2012; Haines, 2009) and geographical service delivery requirements. The selection of factors was based on literature about service design and limitations of IT service SLA data from the case organization. The application ownership denotes provision of intellectual property rights (IPR), which determined to what extent the case organization could alter source code and original designs to change application performance, interoperability, or user experience. BCM activity costs were assumed to correlate differently between internally owned and externally owned technologies.

Two variables were created to test the cost effect of ownership on the cost of BCM – internally owned application costs and externally owned application costs. The selection variable for the ownerships was marked as SV_system_ownership_cost_type.

The second factor related to hypothesis 5 was application customization. The application customization perspective considered technical constraints, such as complexity, standardization and maturity of software, hardware and system integrations in applications and systems (Haines, 2009). The case company's IT service portfolio had three variables for classifying the level of systems customization. The first class, the proprietary customized application class designated unique applications and systems, most of which were designed to meet the product development and production needs of the case organization. While the systems could be built using either open-source and/or commercial components and involving external developers, the systems and their applications were for internal use only, meaning the case organization owned all rights to the system and its applications. The second class, commercial custom application classification included all applications and systems that were developed and provided by the third party. Although the technology was standardized, the actual setup in the case organization was unique compared to other setups in the industry. Applications and systems with this design class were used by common business processes, such as enterprise resource planning, financial planning, and human resources as well as several platforms such as data access and integrations. The third class, commercially configured applications are classified as systems which had functional features available to any organization, but the features are selected based on particular business needs. In the case organization, such applications and systems were considered as common organizational office work and communication tools. Typically, these were off-the-shelf software with standard IT service agreements and licensing. These three classifications were operationalized as SV_system_customization_cost_type.

The third factor related to hypothesis 5 was IT service delivery requirements that could be classified into the two classes – local and global delivery. Because the case organization had both local operations in different countries and global level process, IT service agreements defined requirements for time and location-based delivery, such as access and availability. This requirement affected technical setup, such as use of internet technologies, to enable operations either locally or on global level. The service delivery attribute was marked as SV_service_delivery_cost_type and used as a selection variable to test hypotheses H5. Selection variables listed in table 15 were coded so that if the condition was true, all cost events with that condition were selected and extracted to a separate data file. This approach allowed for selective data sampling through specific strata for hypothesis testing. This coding can be seen in the table 22.

Table 22. Selection variable (SV) by types of cost.

Theoretical variables	Empirical variables (coding in the system)	Operationalized variables
Human resource cost	Internal work cost class (INT)	SV_accounting_cost_type
	External work cost class (EXT)	SV_accounting_cost_type
	Sub-contracting cost class (SUB)	SV_accounting_cost_type
	Outsourcing cost class (OUT)	SV_accounting_cost_type
Technology resource cost	Software purchasing cost class (SW)	SV_accounting_cost_type
	Software maintenance cost class (SWM)	SV_accounting_cost_type
	Hardware purchasing cost class (HW)	SV_accounting_cost_type
	Hardware maintenance cost class (HWM)	SV_accounting_cost_type
Organizational resource cost	IT service provider internal N=1	SV_service_provider_cost_type
	IT service provider external N=3	SV_service_provider_cost_type
IT service design cost	Application/Platform, ownership in organization IT	SV_system_ownership_cost_type
	Application/Platform, ownership outside organization IT	SV_system_ownership_cost_type
	Proprietary customised application	SV_system_customization_cost_type
	Commercial customized application	SV_system_customization_cost_type
	Commercial configured application	SV_system_customization_cost_type
	Regional delivery N=6	SV_service_delivery_cost_type
	Global delivery	SV_service_delivery_cost_type

4.8 Test building

All variables were analyzed by SPSS statistical software. Hierarchical multiple regression analysis was used to test model differences with each of the cost stratum. The hierarchical multiple regression analysis must meet the same assumptions as the standard multiple regression analysis (Field, 2013). With the hierarchical method, a researcher can analyze how the explanatory power of the baseline model can be improved by adding a new variable to the model block by block (Field, 2013). Furthermore, this allows the comparison of effect changes between added variables. In addition to the direct comparison between the groups, in this research the effect size of BCM activities is also compared with the control variables – SLA_security_class and SLA_compliance_class. The assumption is that when independent variables are added into the baseline models one and two, there should be a distinctive effect size increase. Absence of that increase would suggest that BCM activities do not have effect on IT costs.

Table 23. Hierarchical multiple regression analysis test specification.

Variable types		Test model 1	Test model 2	Test model 3
Dependent variables	DV*	(ln)Cost*	(ln)Cost*	(ln)Cost*
Control variables	CV1	SLA_security_class	SLA_security_class	SLA_security_class
	CV2		SLA_compliance_class	SLA_compliance_class
Independent variables	IV1			BCM_analyzing_activity
	IV2			BCM_designing_activity
	IV3			BCM_implementing_activity
	IV4			BCM_embedding_activity
	IV5			BCM_maintenance_activity

*16 strata by type of costs in logarithmic (ln) form (Table 15)

During the test building, control and independent variables were added into the SPSS in the three blocks, denoted as test model 1 (security), test model 2 (security + compliance) and test model 3 (security + compliance + busines continuity management) (Table 23). Although all three test models have been reported in this research, the main interest is on the independent variables of the test model 3 as these are the most relevant for this research. All variables were inserted by enter procedure, i.e., all variables in each block were entered in a single step. By using the stratified purposive sampling technique, the dependent variable, IT cost, was divided into the 16 strata based on the theoretical and empirical observations of IT cost factors discussed in earlier chapters (Table 15). Each stratum with the dependent variable (Table 18) was tested separately.

4.9 Testing the multiple linear regression assumptions

In research, the term validity refers to how accurately a method measures what it is supposed to measure, while the term reliability refers to how consistently a method measures something (Salkind, 2010b). A measurement can be reliable and produce the same result every time, but without being valid, i.e., measuring what it supposed to measure (Salkind, 2010b). However, if a measurement is valid, it is usually also reliable, so research validity is the primary interest when evaluating the research model (Salkind, 2010b). Higher-level validity can support assumptions that theoretical aspects of research reflect real-world properties, characteristics and variations in the physical or social world (Boudreau, 2001).

The purpose of construct validity is to find support for whether the construct it measures is what it is intended to measure (O'Leary-Kelly & Vokurka, 1998). If the construct is consistent with the assumptions and reference metrics, then it can be argued that the construct can measure the relationship between variables as it was suggested (O’Leary-Kelly & Vokurka, 1998). As this research is adopting the multiple regression analysis method, the construct validation is based on the number of commonly accepted tests and observations (Hair, 2010; Tapachnick, 2014; Field, 2016). These tests can be grouped into two main categories – testing the assumptions of whether the multiple regression method is acceptable in this research and testing how well the proposed model explains the relationship between dependent and independent variables, e.g., model fitting by R-square (Ellis, 2010).

The assumptions of the multiple linear regression informs the researcher about the accuracy of estimates, the fit of the model to the data, the variation among variables and whether hypotheses can be rejected or supported with reasonable trust (Hair, 2010; Tapachnick, 2014; Field, 2016). Issues with assumptions such as non-linearity between variables, may require corrections and retesting until assumptions are met or switching to a different method of analysis (Hair, 2010; Tapachnick, 2014; Field, 2016). This chapter informs the reader about the suitability of the multiple regression analysis method for this type of research by presenting eight acceptance results associated with assumptions (Hair, 2010; Tapachnick, 2014; Field, 2016).

The first and second assumptions refer to the type and quantity of variables used in the research (Hair, 2010; Tapachnick, 2014; Field, 2016). The third assumption requires independence of observations and can be tested with the Durbin-Watson method (Field, 2013). The fourth assumes a linear relationship between residuals and the fifth is about observation of the homoscedasticity of the residuals (Field, 2013). The sixth test is used to observe evidence of multicollinearity that can weaken the statistical power of the regression analysis (Field, 2013). The seventh is to observe whether influence points and outliers can skew the results by observing Leverage values (LEV) and Cook’s Distance test (Field, 2013). The eighth assumption is to confirm the normal distribution of the residuals by looking at the data using histograms and the diagonal of the P-P plot (Field, 2013). The results are compared against criteria accepted by the scientific community, and although in many cases a single result may be disputed, it is recommended that all eight factors be considered before multiple regression is accepted as an appropriate method for measuring the BCM activity costs in IT services (Hair, 2010; Tapachnick, 2014; Field, 2016).

The first assumption requires the use of one dependent variable, which is measured at continuous level, i.e., the interval or ratio level (Hair, 2010; Tapachnick, 2014; Field, 2016). Since the dependent variable IT cost data is documented as a continuous number format, the first assumption can be considered supported. Assumption number two requires the use of two or more independent variables measured at either the continuous or nominal level (Hair, 2010; Tapachnick, 2014;

Field, 2016). Since the research model contains 5 independent and 2 control nominal variables operationalized into dummy variables (1 or 0) to meet the requirement, this particular assumption is met (Hair, 2010; Tapachnick, 2014; Field, 2016). The third assumption, the independence of observations, i.e., the independence of the residuals, requires passing the testing criteria of the Durbin-Watson statistic (Hair, 2010; Tapachnick, 2014; Field, 2016). Durbin-Watson was tested for each stratum associated with the hypothesis. The independence test of the residuals in table 24 shows that all 16 strata are within the recommended range 1-3 and close to the optimal value 2 (Hair, 2010; Tapachnick, 2014; Field, 2016). Therefore, it can be stated that the third assumption has been fulfilled.

Table 24. The independence of observations Durbin-Watson test on cost strata.

Stratum: no	Strata name	Durbin-Watson
1	All IT service costs	1.988
2	Internal work costs	1.989
3	External work costs	2.003
4	Software purchasing costs	2.017
5	Software maintenance costs	1.959
6	Hardware purchasing costs	2.026
7	Hardware maintenance costs	1.998
8	Internal service provider costs	2.017
9	External service provider costs	1.993
10	Internally owned application costs	1.990
11	Externally owned application costs	2.007
12	Proprietary customized application costs	2.007
13	Commercial customized application costs	1.989
14	Commercial configured application costs	1.998
15	Regional service delivery costs	2.021
16	Global service delivery costs	1.985

The fourth assumption requires the observation of a linear relationship between the dependent and each of the independent variables (Hair, 2010; Tapachnick, 2014; Field, 2016). Dummy variables are dichotomous variables coded as 1 to indicate the presence of some attribute and as 0 to indicate the absence of that attribute. Consequently, the linearity between two data points is a straight line. Because of this, dummy variables are considered inherently linear so a separate linearity test is not needed. Due to the fact that all independent variables of the research model are dummy variables, the fourth assumption can be considered as fulfilled (Hardy, 1993). In the case when independent variables are continuous variables, linearity can be observed from a scatterplot of the studentized residuals that are plotted against the unstandardized predicted values (Field, 2016). The fifth assumption requires homoscedasticity of the residuals, i.e., equal error variances of data to conform the use of multiple regression analysis. The fulfilment of the assumption can be observed from the scatterplots in figure 10 (Field, 2016).

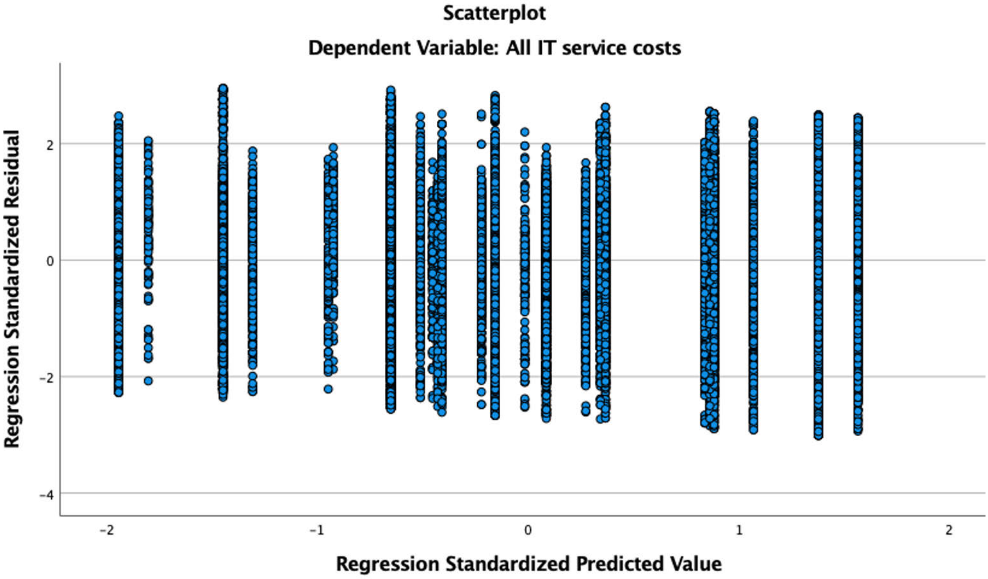

Figure 9. Scatterplot of the stratum 1 (Strata 1-16 in the appendixes 13 & 14).

Homoscedasticity is observable when the spread of the residuals among the predicted values does not increase or decrease significantly, but is scattered approximately constantly (Field, 2016). An uneven spread of residuals, observable as a funnel shape or vertical hourglass shape, would suggest heteroscedasticity in data violating the assumption of homoscedasticity of variance (Field, 2016). The shape of figure 10 shows how the residuals in stratum 1 are uniformly distributed around the zero axis. This suggests that stratum 1. all IT service cost data, is consistent with the homoscedasticity requirement. Looking though critical lenses at all 16 strata, the scatterplot shapes of strata 3, 4, 5, 7 and 14 indicate heteroscedasticity to some extent (Appendixes 13 and 14). However, since the shapes do not significantly violate the assumptions, it can be assumed with some criticism that assumption five is compliant.

The sixth assumption considers the multicollinearity of independent variables. A high correlation between two or more independent variables “multicollinearity” causes a problem because it can weaken the statistical significance of an independent variable (Hair, 2010; Tapachnick, 2014; Field, 2016). In order to identify possible problems, multicollinearity correlation coefficients were reviewed and the tolerance and variance inflation factor (VIF) values were tested (Hair, 2010; Tapachnick, 2014; Field, 2016). Table 24 presents tolerance statistics and the variance inflation factor (VIF) that are used to measure the multicollinearity between independent variables using stratum 1 as an example case (Field, 2013). For tolerance statistics, values higher than 0.2 are generally considered an optimistic indicator, while low values (<0.1) indicate possible problems with multicollinearity (Field, 2013). For the variance inflation factor (VIF), values less than 5 can be considered as an indicator of moderate or low correlations, while values greater than 5 as higher correlations (Field, 2013). According to Hair et al. (2010) there may be a problem with multicollinearity if the VIF value exceeds 4 or the tolerance value is less than 0.2. Some researchers consider that the VIF value 10 was the threshold for problems. Using >0.2 (tolerance) and <4 (VIF) as a rule, all of the independent and control variables were in the range of optimum values. Since the values of all independent and control variables were within the acceptable ranges in all test models 1, 2 and 3 in all strata, it can be concluded that assumption six was met (Appendix 15).

Table 25. Multicollinearity tolerance and VIF test on stratum 1 (Strata 1-16 in the appendix 15).

Variables	**Test model 1**		**Test model 2**		**Test model 3**	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
CV1	1.000	1.000	1.000	1.000	0.979	1.021
CV2			1.000	1.000	0.993	1.007
IV1					0.963	1.038
IV2					0.981	1.020
IV3					0.926	1.080
IV4					0.919	1.088
IV5					0.870	1.150

The seventh assumption concerns certain data points that can be considered as abnormal when fitting the test model in multiple regression (Field, 2016). These data points can cause problems with the regression equation, leading to biased results. During the analysis, outliers, high leverage points and highly influential points require attention (Field, 2016). Outliers are data points that do not follow the usual pattern of points and are far from the predicted value (Field, 2016). During the analysis, the default option of SPSS Statistics Casewise diagnostics was used. Standardized residuals greater than ±3 were examined to determine whether they should be removed or left in the test models (Field, 2016). The same reference value was used in studentized deleted residuals examinations. The result from tested strata shows both minimum and maximum standardized residuals and studentized deleted residuals which exceed the reference value ±3. However, a detailed review showed that the number of outliers was relatively low per stratum. This is also supported by the mean value of the residuals, which is systematically 0.0 in the strata. Leverage values exceeding 0.5 may imply unusual data points that may create issues, while values below 0.2 are considered safe for the test models (Field, 2016). As the Maximum Centered Leverage values in the figure show, the tested strata pass the given requirements undoubtedly (Appendix 16). Considering influential values, the Cook's Distance test can determine if a case is influential. As table 25 shows, none of Cook's stratum distance values exceed the optimal control value of 1, confirming the absence of influential values (Field, 2016). Overall, the results suggest that the test models were not compromised by possible influential data points.

Table 26. Detection of unusual data points stratum 1 (Strata 1-16 in the appendix 16).

	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.007	2.947	0.000	1.000	57040
Stud. Deleted Residual	-3.008	2.947	0.000	1.000	57040
Cook's Distance	0.000	0.001	0.000	0.000	57040
Centered Leverage Value	0.000	0.001	0.000	0.000	57040

The eighth and at the same time final assumption assumes normality of the distribution of residual. This is a prerequisite to conduct inferential statistics, i.e., to determine statistical significance α (Field, 2013). Two common methods can be used to check the assumption of normality of the residuals – a histogram with superimposed normal curve and a probability–probability plot (P-P Plot). Visual observation of the strata in appendix 13 and 14, how the residuals were arranged in both the histograms and the P-P plots, suggests that all strata were normally distributed, and the residuals were not skewed. As the results in figures 11 and 12 as well as appendixes 13 and 14 show, the condition for assumption 8 was met.

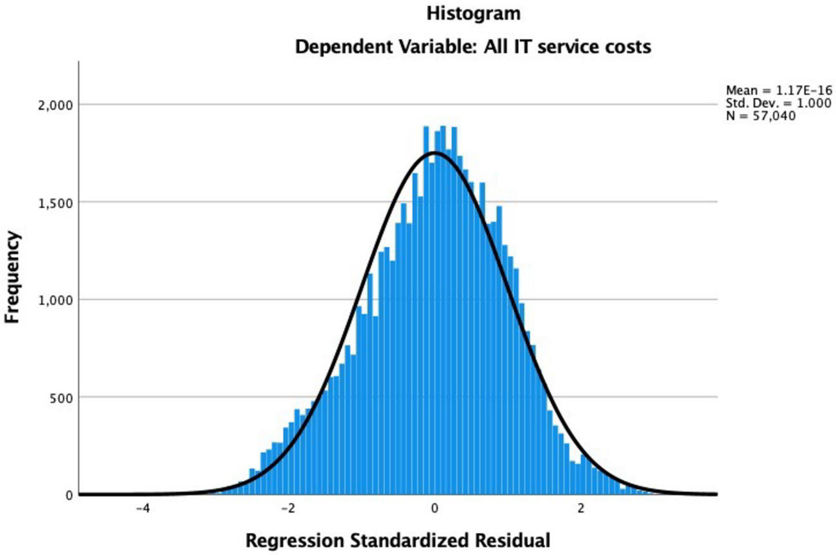

Figure 10. Normal distribution on stratum 1 (Strata 1-16 in the appendix 13 and 14).

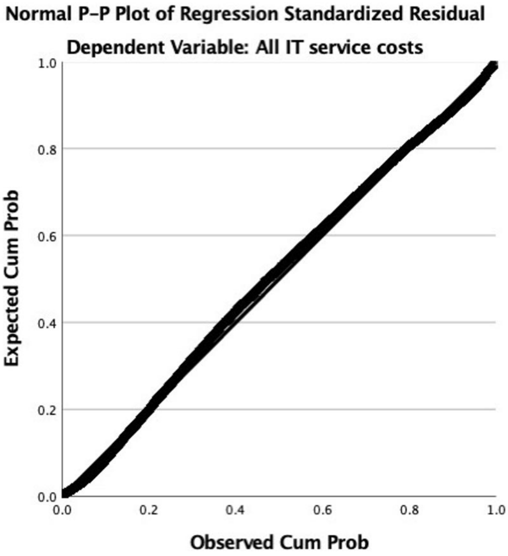

Figure 11. Skewness of a distribution on stratum 1 (Strata 1-16 in the appendix 13 and 14).

Considering all eight assumptions and the proposed acceptable range of values, it can be argued that multiple linear regression analysis is a valid method for analyzing categorical variables, converted into the dummy variables on cost type of data (Table 26). While this observation partially supports the proposal of Benston (1966) to use

MLR to measure unknown cost factors, it does not test the construct validity of BCM activities on IT service costs. This will be discussed in the next chapters.

Table 27. Fulfilment of the assumptions of multiple linear regression analysis.

Assumptions	Validation	Acceptable values	Fulfilment
Dependent variable	variable type	continuous variable	yes
Independent variable	variable numbers	two or more variables	yes
independence of observations	Durbin-Watson	1-3	yes
Linear relationship of DV and IV	scatterplot	dummy variables linearity by default	yes
Homoscedasticity of the residuals	scatterplot	equal spread of residuals	yes
Multicollinearity of independent variables	Tolerance/ VIF	>0.2 / < 5	yes
Effect of influential values	Casewise Diagnostics	±3	yes
	Centered Leverage Values	<0.5	yes
	Cook's Distance	<1	yes
Normal distribution	histogram	residual fit with normality curve	yes
Skewness of normal distribution	P-P Plot	residual fit with line	yes

5 Research results

The research results chapter consists of five subchapters reflecting five null hypothesis–alternative hypothesis pairings (Table 10) and 16 strata organised by cost categories. Results and observations on each stratum are presented in the following order: 1) testing the null hypothesis on each three test models by analysis of variance, 2) testing the effect sizes on each three test models by goodness of fit tests 3) testing the null-hypothesis and measuring the unstandardized coefficients (B) value on each independent and control variable, and 4) percentage impacts of each independent variables on dependent variables to present practical view of the cost effect. The interpretation of the overall results in relation to the main research question is in the discussions chapter. The observations that are not directly relevant to the research hypotheses and the research questions are discussed in the chapter on future research, which includes control variables as a separate activity cost research. The descriptive data for each of the tested stratum can be found in the appendix 17.

5.1 IT service costs (H1)

The aim of testing the IT service costs was to observe the overall effect of BCM activities on those cost factors that were defined by the case company as standard IT cost factors for business applications. The null hypothesis H1 ‘there is no IT service cost difference between IT service with BCM activities and IT service without BCM activities’ was tested for all IT service costs (Stratum 1). This testing is based on a single stratum that combined following cost types: internal work costs, external work costs, sub-contracting costs, outsourcing costs, software purchasing costs, software maintenance costs, hardware purchasing costs and hardware maintenance costs (Table 22). Other cost types were excluded from the dependent variable as they were not measured by the case organization as a part of IT service cost management. Independent variables that entered in the test models are presented in the table 23.

Table 28. Analysis of variance, stratum 1 all IT service costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	151.354	1	151.354	310.700	.000
	Residual	27785.471	57038	0.487		
	Total	27936.826	57039			
Model 2	Regression	604.807	2	302.404	631.062	.000
	Residual	27332.018	57037	0.479		
	Total	27936.826	57039			
Model 3	Regression	1318.150	7	188.307	403.459	.000
	Residual	26618.676	57032	0.467		
	Total	27936.826	57039			

Table 28 presents the first results of the tests. According to the analysis of variance on IT services costs, the null hypothesis can be rejected with acceptable probability on all three test models ($p < .05$). In other words, it is likely that the test results are not random observations. Thus, the alternative hypothesis that the BCM activities correlate with IT costs can be suggested.

Table 29. Models' goodness of fit, stratum 1 all IT service costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.074	0.005	0.005	0.69795	0.005	310.700	1	57038	0.000
Model 2	.147	0.022	0.022	0.69224	0.016	946.275	1	57037	0.000
Model 3	.217	0.047	0.047	0.68318	0.026	305.675	5	57032	0.000

The table 29 shows how entering the security control variable to the test model 1 produced the effect size $R^2 = .005$ (adjusted $R^2 = .005$) (Table 29). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.022$ (adjusted $R^2 =.022$) was observed, with the change effect $\Delta R^2 = .016$. For the full model (test model 3) the effect size $R^2 =.047$ (adjusted $R^2 =.047$) was observed, with the change effect $\Delta R^2 = .026$. The changes between the models indicate a distinctive 2.6% effect of BCM activities on IT service cost. Reflecting on Cohen (1988), the effect sizes are small but not insignificant ($R^2 > .02$). Given the context in which IT services are subject to multiple cost factors, e.g., (Irani et al., 2006), it can be expected that BCM activities explain only a relatively small proportion of total IT service costs. Therefore, it can be argued that the practical significance of the test model 3 can be supported.

Unlike the tests in the tables 28 and 29, the table 30 presents both null-hypothesis and the practical results on each variable. The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 30). In the full model (test model 3) the p-value (p =.737) of the IV BCM_ Designing activity suggests that the variable has no correlation with the dependent variable (p > .05). In other words, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 2. Since the test model 3 was supported, this suggests that BCM activity costs could be measured only by four activity types. This observation can trigger discussions on the theoretical and practical differences in BCM frameworks. This research does not argue that there is a specific number of activities that can be considered as the best alternative to others. It simply observes that as costs are associated to something that can be consider tangible, it could imply that what is considered as an ideal or common structure, could be analyzed from economical perspective too.

Table 30. Model's coefficents, stratum 1 all IT service costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	-0.025	0.009		-2.882	0.004
CV1	SLA_security_class	-0.081	0.005	-0.060	-14.745	0.000
Model 2	Constant	-0.025	0.009		-2.882	0.004
CV1	SLA_security_class	-0.081	0.005	-0.060	-14.745	0.000
CV2	SLA_compliance_class	0.124	0.003	0.169	40.470	0.000
Model 3	Constant	-0.045	0.009		-5.198	0.000
CV1	SLA_security_class	-0.060	0.005	-0.045	-10.964	0.000
CV2	SLA_compliance_class	0.122	0.003	0.166	39.826	0.000
IV1	BCM_Analyzing*	0.156	0.015	0.042	10.102	0.000
IV2	BCM_Designing**	-0.007	0.021	-0.001	-0.335	0.737
IV3	BCM_Implementing*	0.145	0.011	0.056	13.222	0.000
IV4	BCM_Embedding*	0.194	0.010	0.083	19.149	0.000
IV5	BCM_Maintenance*	0.191	0.007	0.122	26.458	0.000

* Rejected null hypothesis
** Supported null hypothesis

Unstandardized coefficients (B) in the table 30 can be transformed into percentages for further analysis. As an example, the B= 0.156 on BCM_Analyzing can be converted to percentages by following Halvorsen & Palmquist (1980) rule 100(exp(B) - 1) = ~16%. According to this corrected (Halvorsen & Palmquist, 1980) measurement of the unstandardized coefficients (B), the percentage change between units (0 to 1) change in independent variables have averages of ~+18% unit impact (Table 31) when the reference group, standard IT service, is switched to the comparison group, IT service with BCM. In other words, if BCM activities are included in standard IT service management, an impact of ~+18% on IT service costs can be expected.

Table 31. The proportional impact on stratum 1 all IT service costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	16%	2%	17%	30%	26%	18%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent the difference between two groups, not between each activity class.

5.2 Human resource costs (H2)

To test the correlations between BCM and human resource costs, the null hypothesis H2 ‘there is no human resource cost difference between IT service with BCM activities and IT service without BCM activities’ was proposed. The testing results present two strata: internal work costs (Stratum 2) and external work costs (Stratum 3). Independent variables that entered the test models are presented in table 23. The descriptive data for the stratum can be found in appendix 17. The goal was to observe the extent to which BCM activities consume human resources and thus generate work cost for the case organization’s employees as well as external employees, e.g., sub-contracting and on-site consultancy. This is not a trivial perspective as human resources, including consulting and outsourced staff, can account for the largest share of IT spending. According to Luftman et al.(2015), in the same period in which this research data was collected, about 60% of IT budgets were allocated to human resources. In recent years, the share of human resources in IT departments' budgets has remained the highest (Kappelman et al., 2021).

5.2.1 Internal work costs

Internal work costs are generated by the case company’s own employees on permanent or part-time contracts. These costs include all human resource costs, including salaries, overtime costs, social security, insurances, supported hobbies/ events, travels and rewards on good performance. Table 32 presents the test results on the statistical significance of the presented test models on internal work costs – stratum 2. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all test models ($p < .05$).

Table 32. Analysis of variance, stratum 2 internal work costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	105.961	1	105.961	286.311	.000
	Residual	14889.420	40232	0.370		
	Total	14995.380	40233			
Model 2	Regression	226.021	2	113.010	307.835	.000
	Residual	14769.359	40231	0.367		
	Total	14995.380	40233			
Model 3	Regression	628.884	7	89.841	251.552	.000
	Residual	14366.496	40226	0.357		
	Total	14995.380	40233			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .007$ (adjusted $R^2 = .007$) (Table 33). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.015$ (adjusted $R^2 =.015$) was observed, with the change effect $\Delta R^2 = .008$. For the full model (test model 3) the effect size $R^2 =.042$ (adjusted $R^2 =.042$) was observed, with the change effect $\Delta R^2 = .027$. The changes between models indicate a distinctive 2.7% effect by BCM activities on internal work costs. In line with the observation of stratum 1. it can be argued that the practical significance of the model can be supported ($R^2 > .02$).

Table 33. Models' goodness of fit, stratum 2 internal work costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.084	0.007	0.007	0.60835	0.007	286.311	1	40232	0.000
Model 2	.123	0.015	0.015	0.60590	0.008	327.038	1	40231	0.000
Model 3	.205	0.042	0.042	0.59762	0.027	225.602	5	40226	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but two independent variables* (Table 34). In the full model (test model 3) the p-value ($p =.211$) of IV BCM_Analyzing activity and the p-value ($p =.206$) of IV BCM_ Designing activity suggest that the variables have no correlations with the dependent variable ($p > .05$). Similar to observation related to H1, there is insufficient evidence to conclude that the BCM activity costs can be determined by five activity types, as proposed in chapter 2. This observation will be discussed later in relation with other test observations.

Table 34. Models' coefficents, stratum 2 internal work costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.310	0.004		73.587	0.000
CV1	SLA_security_class	-0.103	0.006	-0.084	-16.921	0.000
Model 2	Constant	0.217	0.007		32.795	0.000
CV1	SLA_security_class	-0.104	0.006	-0.085	-17.199	0.000
CV2	SLA_compliance_class	0.125	0.007	0.089	18.084	0.000
Model 3	Constant	0.116	0.007		15.764	0.000
CV1	SLA_security_class	-0.077	0.006	-0.063	-12.862	0.000
CV2	SLA_compliance_class	0.118	0.007	0.084	17.211	0.000
IV1	BCM_Analyzing**	0.020	0.016	0.006	1.251	0.211
IV2	BCM_Designing**	0.029	0.023	0.006	1.264	0.206
IV3	BCM_Implementing*	0.081	0.011	0.036	7.082	0.000
IV4	BCM_Embedding*	0.198	0.010	0.099	19.402	0.000
IV5	BCM_Maintenance*	0.219	0.007	0.164	31.059	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables has ~+12% unit impact (Table 35). In other words, if BCM activities are included in standard IT service management, an impact of ~+12% on IT service internal work costs can be expected.

Table 35. The proportional impact on stratum 2 internal work costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	2%	3%	8%	22%	25%	12%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.2.2 External work costs

The cost of external work includes all sub-contracting, outsourcing and on-site consultancy accounted for the work of external parties. Table 36 presents the test results on statistical significance of the presented test models on external work costs – stratum 3. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 36. Analysis of variance, stratum 3 external work costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	15.237	1	15.237	27.863	.000
	Residual	9703.466	17744	0.547		
	Total	9718.703	17745			
Model 2	Regression	44.425	2	22.212	40.738	.000
	Residual	9674.279	17743	0.545		
	Total	9718.703	17745			
Model 3	Regression	141.571	7	20.224	37.458	.000
	Residual	9577.132	17738	0.540		
	Total	9718.703	17745			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .002$ (adjusted $R^2 = .002$) (Table 36). By adding the compliance control variable to the test model 2. the effect size $R^2 =.005$ (adjusted $R^2 =.004$) was observed, with the change effect $\Delta R^2 = .003$. For the full model (test model 3) the effect size $R^2 =.015$ (adjusted $R^2 =.014$) was observed, with the change effect $\Delta R^2 = .010$. The changes between test models indicate a distinctive 1.0% effect by BCM activities on external work costs. This result is half of what was observed in the stratum 1 testing, reaching very low effect size ($R^2 < .02$) With this low value, it can be argued that the practical significance of the model is uncertain. This would suggest that the test model does not measure work costs that are caused by external actors.

Table 37. Models' goodness of fit, stratum 3 external work costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.040	0.002	0.002	0.73950	0.002	27.863	1	17744	0.000
Model 2	.068	0.005	0.004	0.73841	0.003	53.531	1	17743	0.000
Model 3	.121	0.015	0.014	0.73479	0.010	35.985	5	17738	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all independent variables (Table 37). In other words, there is sufficient evidence to propose that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3.

Table 38. Models' coefficents, stratum 3 external work costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.697	0.008		88.346	0.000
CV1	SLA_security_class	0.059	0.011	0.040	5.279	0.000
Model 2	Constant	0.618	0.013		46.019	0.000
CV1	SLA_security_class	0.056	0.011	0.038	5.068	0.000
CV2	SLA_compliance_class	0.101	0.014	0.055	7.317	0.000
Model 3	Constant	0.559	0.015		38.440	0.000
CV1	SLA_security_class	0.070	0.011	0.047	6.310	0.000
CV2	SLA_compliance_class	0.096	0.014	0.052	6.986	0.000
IV1	BCM_Analyzing*	0.117	0.030	0.030	3.906	0.000
IV2	BCM_Designing*	-0.219	0.048	-0.034	-4.543	0.000
IV3	BCM_Implementing*	0.109	0.022	0.038	4.944	0.000
IV4	BCM_Embedding*	0.098	0.020	0.037	4.845	0.000
IV5	BCM_Maintenance*	0.153	0.013	0.089	11.377	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to the corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in the independent variables has a unit impact of ~+6% (Table 39). In other words, by adding BCM activities into the standard IT service management, an impact of ~+6% on IT service external work costs can be expected.

Table 39. The proportional impact on stratum 3 external work costs.

Model 3	IV1	IV2	IV3	IV4	IV5	$\bar{X}$
Impact %	12%	-20%	12%	10%	16%	6%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.2.3 Summary of human resource costs

The hypothesis 2 (H2) tested the correlation between human resource costs and BCM activities incorporating two strata – internal work costs and external work costs. During the testing the null hypotheses were rejected based on the results from both strata (Table 32 and 36) Looking at both strata 2 and 3, internal and external work costs, the difference between strata is observable. The test models effect on internal work costs $\Delta R^2 = 0.027$ compared to the external work costs effect $\Delta R^2 = 0.010$.

shows the difference – external costs are roughly one third of internal costs. While theoretical significance for this hypothesis is supported in both observations, the test model on external works is not well supported. According to SIM IT, e.g, Kappelman et al. (2021), the total work costs of contractors and consultants are around 6% to 7% of the IT budgets, while the total costs of employees are approximately between 31% to 46% of the IT budgets (Appendix 18). Comparing the relative work cost differences from the survey with the observations of the BCM activity cost effect size, they seem to have the same proportional difference, though with high ballpark. Beside the point of reference that might explain the difference between results, the other explanation could be that the case organization assigned the BCM work to the internal IT service teams rather than to the external teams. Considering the above, it can be assumed that the test model does explain the effect on external work, but due to the low use of external work, the effect size is very small. If we accept this explanation, the practical significance can be supported, arguing that there is a difference in human resource costs between IT service with BCM activities and IT service without BCM activities. This can be supported by calculating the average from strata 2 and 3, resulting in the average of $\Delta R^2 = 0.019$ (min. 0.010. max. 0.027). However, it is possible that some portions of the activities are done in another unit, it can be argued that in the case company, BCM activities can explain on average 1.9% of the cost variation of IT services human resource costs.

5.3 Technology resource costs (H3)

To test the correlations between BCM and technology resource costs, the null hypothesis H3 ‘there is no technology resource cost difference between IT service with BCM activities and IT service without BCM activities’ was proposed. The testing results are based on four strata: software purchasing costs (stratum 4), software maintenance costs (stratum 5), hardware purchasing costs (stratum 6) and hardware maintenance costs (stratum 7). Independent variables entered the test models are presented in the table 23. The descriptive data for the stratum can be found from the appendix 17. The goal was to observe to what extent BCM activities consume technology resources, categorically software and hardware resources' initial and ongoing costs. Spending on infrastructure, namely hardware, software, and networking, can account for about 40% of the total IT budget, out of which 25% can be expenses from outsourced infrastructure (Luftman et al., 2015). Recent years this cost has become the second biggest cost category after human resources, accounting 32% from IT budgets (Kappelman et al., 2021).

5.3.1 Software purchasing costs

The first test studies software purchasing stratum that comprises initial costs of commercial software codes and components immaterial rights such like right to customize and modify the code or functionality of a software. According to the Table 40 analysis of variance on software purchasing costs, it can be suggested to reject the null hypothesis on all models ($p < .05$).

Table 40. Analysis of variance, stratum 4 software purchasing costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	8.597	1	8.597	8.394	.004
	Residual	4579.025	4471	1.024		
	Total	4587.622	4472			
Model 2	Regression	182.826	2	91.413	92.766	.000
	Residual	4404.796	4470	0.985		
	Total	4587.622	4472			
Model 3	Regression	334.014	7	47.716	50.088	.000
	Residual	4253.607	4465	0.953		
	Total	4587.622	4472			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .002$ (adjusted $R^2 = .002$) (Table 41). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.040$ (adjusted $R^2 =.039$) was observed, with the change effect $\Delta R^2 = .038$. For the full model (test model 3) the effect size $R^2 =.073$ (adjusted $R^2 =.071$) was observed, with the change effect $\Delta R^2 = .033$. The changes between models indicate a distinctive 3.3% effect by BCM activities on software purchasing costs. Reflecting Cohen (1988), the full model effect sizes suggest higher than the cut-off value for small ($R^2 > .02$) thus it can be argued that the practical significance of the model can be supported.

Table 41. Models' goodness of fit, stratum 4 software purchasing costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.043	0.002	0.002	1.01201	0.002	8.394	1	4471	0.004
Model 2	.200	0.040	0.039	0.99268	0.038	176.808	1	4470	0.000
Model 3	.270	0.073	0.071	0.97604	0.033	31.740	5	4465	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 42). In the full model (test model 3) the p-value ($p =.173$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable (p > .05). Because of this, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as hypothesized earlier in the chapter 3. This observation is discussed later in relation with other test observations.

Table 42. Models' coefficents, stratum 4 software purchasing costs.

		B	**Std. Error**	**β**	**t**	**Sig.**
Model 1	Constant	0.154	0.021		7.298	0.000
CV1	SLA_security_class	-0.082	0.028	-0.043	-2.897	0.004
Model 2	Constant	-0.110	0.029		-3.821	0.000
CV1	SLA_security_class	-0.125	0.028	-0.066	-4.466	0.000
CV2	SLA_compliance_class	0.250	0.019	0.196	13.297	0.000
Model 3	Constant	-0.217	0.031		-7.064	0.000
CV1	SLA_security_class	-0.091	0.028	-0.048	-3.288	0.001
CV2	SLA_compliance_class	0.227	0.019	0.178	12.143	0.000
IV1	BCM_Analyzing*	0.691	0.073	0.139	9.490	0.000
IV2	BCM_Designing**	-0.171	0.126	-0.020	-1.364	0.173
IV3	BCM_Implementing*	0.459	0.056	0.121	8.150	0.000
IV4	BCM_Embedding*	0.281	0.058	0.072	4.836	0.000
IV5	BCM_Maintenance*	0.145	0.037	0.060	3.969	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+38% unit impact (Table 43). In other words, adding BCM activities into the standard IT service management, it can be expected ~+38% impact on IT service software licensing and purchasing costs.

Table 43. The proportional impact on stratum 4 software purchasing costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	100%	-16%	58%	32%	16%	38%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.3.2 Software maintenance costs

Software maintenance costs includes immaterial costs of license fees and such added software components or code libraries that were not covered in the fixed fees. According to the Table 44 analysis of variance on software maintenance costs, it can be suggested to reject the null hypothesis on all models ($p < .05$).

Table 44. Analysis of variance, stratum 5 software maintenance costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	14.377	1	14.377	24.090	.000
	Residual	3180.910	5330	0.597		
	Total	3195.286	5331			
Model 2	Regression	149.478	2	74.739	130.765	.000
	Residual	3045.808	5329	0.572		
	Total	3195.286	5331			
Model 3	Regression	294.717	7	42.102	77.279	.000
	Residual	2900.569	5324	0.545		
	Total	3195.286	5331			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .004$ (adjusted $R^2 = .004$) (Table 45). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.047$ (adjusted $R^2 =.046$) was observed, with the change effect $\Delta R^2 = .042$. For the full model (test model 3) the effect size $R^2 =.092$ (adjusted $R^2 =.091$) was observed, with the change effect $\Delta R^2 = .045$. The changes between test models shows 4,5% effect by BCM activities on software maintenance costs. Reflecting Cohen (1988), the full model effect sizes suggest higher than the cut-off value for small ($R^2 > .02$) thus it can be argued that the practical significance of the model can be supported.

Table 45. Models' goodness of fit, stratum 5 software maintenance costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.067	0.004	0.004	0.77252	0.004	24.090	1	5330	0.000
Model 2	.216	0.047	0.046	0.75601	0.042	236.375	1	5329	0.000
Model 3	.304	0.092	0.091	0.73811	0.045	53.317	5	5324	0.000

The p-value (Sig.) for tested independent variables shows that the null hypothesis can be rejected on all but one independent variable (Table 46). In the full model (test model 3) the p-value ($p =.293$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable ($p > .05$). In other words, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3. This observation is discussed later in relation with other test observations.

Table 46. Models' coefficents, stratum 5 software maintenance costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.617	0.015		40.371	0.000
CV1	SLA_security_class	-0.104	0.021	-0.067	-4.908	0.000
Model 2	Constant	0.312	0.025		12.546	0.000
CV1	SLA_security_class	-0.124	0.021	-0.080	-5.987	0.000
CV2	SLA_compliance_class	0.396	0.026	0.206	15.375	0.000
Model 3	Constant	0.170	0.026		6.532	0.000
CV1	SLA_security_class	-0.081	0.021	-0.052	-3.949	0.000
CV2	SLA_compliance_class	0.372	0.025	0.193	14.617	0.000
IV1	BCM_Analyzing*	0.253	0.051	0.066	4.967	0.000
IV2	BCM_Designing**	-0.098	0.093	-0.014	-1.052	0.293
IV3	BCM_Implementing*	0.360	0.041	0.120	8.889	0.000
IV4	BCM_Embedding*	0.416	0.039	0.142	10.586	0.000
IV5	BCM_Maintenance*	0.303	0.025	0.167	12.186	0.000

* Rejected null hypothesis

** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+30% unit impact (Table 47). In other words, adding BCM activities into the standard IT service management, it can be expected ~+30% impact on IT service maintenance costs.

Table 47. The proportional impact on stratum 5 software maintenance costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	29%	-9%	43%	52%	35%	30%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.3.3 Hardware purchasing costs

Hardware purchasing costs consider acquiring application specific hardware and tools for configuration management. Table 48 presents the test results on statistical significance of the presented models on hardware purchasing costs – stratum 2. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 48. Analysis of variance, stratum 6 hardware purchasing costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	69.345	1	69.345	43.181	.000
	Residual	7054.763	4393	1.606		
	Total	7124.108	4394			
Model 2	Regression	214.749	2	107.374	68.253	.000
	Residual	6909.360	4392	1.573		
	Total	7124.108	4394			
Model 3	Regression	414.416	7	59.202	38.708	.000
	Residual	6709.692	4387	1.529		
	Total	7124.108	4394			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .010$ (adjusted $R^2 = .010$) (Table 49). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.030$ (adjusted $R^2 =.030$) was observed, with the change effect $\Delta R^2 = .020$. For the full model (test model 3) the effect size $R^2 =.058$ (adjusted $R^2 =.057$) was observed, with the change effect $\Delta R^2 = .028$. The changes between models indicates distinctive 2.8% effect by BCM activities on hardware purchasing costs. Reflecting Cohen (1988), the full model effect sizes indicate small effect ($R^2 > .02$). Considering the context, it can be argued that the practical significance of the model can be supported.

Table 49. Goodness of fit, stratum 6 hardware purchasing costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.099	0.010	0.010	1.26725	0.010	43.181	1	4393	0.000
Model 2	.174	0.030	0.030	1.25426	0.020	92.427	1	4392	0.000
Model 3	.241	0.058	0.057	1.23671	0.028	26.110	5	4387	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 50). In the full model (test model 3) the p-value ($p =.605$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable (p > .05). In other words, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3. This observation is discussed later in relation with other test observations.

Table 50. Models' coefficents, stratum 6 hardware purchasing costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	-0.448	0.027		-16.903	0.000
CV1	SLA_security_class	-0.251	0.038	-0.099	-6.571	0.000
Model 2	Constant	-0.766	0.042		-18.149	0.000
CV1	SLA_security_class	-0.250	0.038	-0.098	-6.599	0.000
CV2	SLA_compliance_class	0.421	0.044	0.143	9.614	0.000
Model 3	Constant	-0.927	0.045		-20.647	0.000
CV1	SLA_security_class	-0.189	0.038	-0.074	-4.990	0.000
CV2	SLA_compliance_class	0.367	0.044	0.124	8.376	0.000
IV1	BCM_Analyzing**	0.057	0.110	0.008	0.517	0.605
IV2	BCM_Designing*	0.235	0.110	0.032	2.134	0.033
IV3	BCM_Implementing*	0.517	0.072	0.109	7.216	0.000
IV4	BCM_Embedding*	0.574	0.071	0.123	8.074	0.000
IV5	BCM_Maintenance*	0.357	0.048	0.115	7.467	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+44% unit impact (Table 51). In other words, adding BCM activities into the standard IT service management, it can be expected ~+44% impact on IT service hardware purchasing costs.

Table 51. The proportional impact on stratum 6 hardware purchasing costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	6%	26%	68%	77%	43%	44%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.3.4 Hardware maintenance costs

Hardware maintenance costs includes expenses for upgraded and new components and related tools to maintain systems operations on. Table 52 presents the test results on statistical significance of the presented models on hardware maintenance costs – stratum 7. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 52. Analysis of variance, stratum 7 hardware maintenance costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	28.783	1	28.783	45.446	.000
	Residual	2268.663	3582	0.633		
	Total	2297.447	3583			
Model 2	Regression	122.503	2	61.252	100.850	.000
	Residual	2174.943	3581	0.607		
	Total	2297.447	3583			
Model 3	Regression	363.676	7	51.954	96.075	.000
	Residual	1933.770	3576	0.541		
	Total	2297.447	3583			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .013$ (adjusted $R^2 = .012$) (Table 53). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.053$ (adjusted $R^2 =.053$) was observed, with the change effect $\Delta R^2 = .041$. For the full model (test model 3) the effect size $R^2 =.158$ (adjusted $R^2 =.157$) was observed, with the change effect $\Delta R^2 = .105$. The changes between models indicates distinctive 10.5% effect by BCM activities on hardware maintenance costs. Reflecting Cohen (1988), the full model effect sizes cut-off value shows closed to medium effect by the model ($R^2 >.02$ and $<.15$). Based on this result, the practical significance of the model can be supported.

Table 53. Goodness of fit, stratum 7 hardware maintenance costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.112	0.013	0.012	0.79583	0.013	45.446	1	3582	0.000
Model 2	.231	0.053	0.053	0.77933	0.041	154.308	1	3581	0.000
Model 3	.398	0.158	0.157	0.73537	0.105	89.197	5	3576	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all independent variables (Table 54). There is sufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as discussed earlier in the chapter 3.

Table 54. Models' coefficents, stratum 7 hardware maintenance costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.267	0.018		14.522	0.000
CV1	SLA_security_class	-0.179	0.027	-0.112	-6.741	0.000
Model 2	Constant	-0.002	0.028		-0.064	0.949
CV1	SLA_security_class	-0.197	0.026	-0.123	-7.557	0.000
CV2	SLA_compliance_class	0.372	0.030	0.202	12.422	0.000
Model 3	Constant	-0.226	0.029		-7.838	0.000
CV1	SLA_security_class	-0.127	0.025	-0.079	-5.083	0.000
CV2	SLA_compliance_class	0.347	0.029	0.189	12.153	0.000
IV1	BCM_Analyzing*	0.440	0.076	0.090	5.813	0.000
IV2	BCM_Designing*	0.379	0.069	0.086	5.515	0.000
IV3	BCM_Implementing*	0.470	0.049	0.151	9.631	0.000
IV4	BCM_Embedding*	0.663	0.045	0.232	14.740	0.000
IV5	BCM_Maintenance*	0.518	0.033	0.249	15.586	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+65% unit impact (Table 55). In other words, adding BCM activities into the standard IT service management, it can be expected ~+65% impact on IT service hardware maintenance costs.

Table 55. The proportional impact on stratum 7 hardware maintenance costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\overline{X}$
Impact %	55%	46%	60%	94%	68%	65%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.3.5 Summary of technology resource costs

Testing of the technology resource cost difference between IT service with BCM activities and IT service without BCM activities suggest that the null hypothesis H3 can be rejected (Table 40, 44, 48 and 52). This cost category gets the highest effect size values from all 16 strata (Table 92) with the average $\Delta R^2 = 0.053$ (min. 0.028, max. 0.105), suggesting that BCM activities could explain ~5.3% of software and hardware costs. Considering the IT services lifecycle costs, on average 7.5% of technology maintenance costs can be explained by BCM activities, taking into account the costs in the maintenance phase, especially the effect of BCM activities on hardware maintenance costs is large compared to all other cost types tested. When looking at the case company's IT service continuity management plans, how BCM was practically integrated in the case company's IT services, the range of technologies used was wide and included, e.g., fault-tolerance systems, server clustering, secondary data storages, redundant internet connections as well as data mirroring.

Although the standard continuity and recovery solutions were not managed by BCM, they certainly created technology costs that were not captured by this the research. It can be assumed that the cost of all business continuity technologies would likely exceed the estimated average effect of 5.3% on technology costs explained by BCM activities. From a methodological point of view, it is interesting that measuring organizational routines (Feldman & Pentland, 2003) at a structural level can reveal ongoing costs of technology components. Since individuals and groups perform out activities, the observation of human resource costs types was implicitly expected. When we look at the respective years with the research sample 2006 - 2012 (Luftman, 2008, 2008, 2009, 2010, 2011, 2012; Kappelman et al., 2013), on an annual average employee costs represent ~40% of the IT budget, whereas technology costs represent ~33% of the budget. In this research, the impact of BCM activities on average human resource cost of $\Delta R^2 = 0.019$ and on technology resources of $\Delta R^2 = 0.053$ was observed. When we compare "apples-to-apples, i.e., the 2006 - 2012 survey results with the 1.9% and 5.3% case company results, this suggests that the survey trends of IT budget allocations cannot simply be extrapolated to BCM in IT services. In contrast to the surveys on the distribution of IT costs for SIM IT issues, IT service continuity in the case company was largely technology-driven, as the BCM activity cost effect was twice more on hardware and software costs than on people costs. This supports the argument that for IT service teams, technology-driven BCM was the primary approach for IT service continuity management, especially regarding investments in hardware-based solutions. From a methodological point of view, the research approach can offer an interesting application to not only measure indirect costs such as activities, but also to capture costs that are considered direct cost factors, such as technology procurement and maintenance cost factors. Overall, it can be argued that BCM activities can explain part of technology costs in IT services.

5.4 Organizational resource costs (H4)

To test the correlations between BCM and organizational resource costs, the null hypothesis H4 'there is no organizational resource cost difference between IT service with BCM activities and IT service without BCM activities' was proposed. The testing results are based on two strata: internal service provider costs and external service provider costs. Independent variables entered the test models are presented in the table 23. The descriptive data for the stratum can be found from the appendix 17. The goal was to observe how the cost of BCM activities would differ between organizations. In this context, organizations are divided into internal and external IT service organizations. Internal organization cost considers any cost factors associated to those IT services that were hosted by the case company's own IT unit. External organization costs consider any cost factors that were associated to the IT services hosted by any external service provider.

5.4.1 Internal service provider costs

The first testing studies internal service provider costs stratum 8. According to the Table 56 analysis, it can be suggested to reject the null hypothesis on models 2 and 3 models ($p < .05$). Test model 1 result support null hypothesis, however as the full model 3 is the main observed model, the result should not cause issues on the statistical significance testing goal.

Table 56. Analysis of variance, stratum 8 internal service provider costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	0.113	1	0.113	0.502	.479
	Residual	2452.980	10901	0.225		
	Total	2453.093	10902			
Model 2	Regression	56.915	2	28.457	129.450	.000
	Residual	2396.178	10900	0.220		
	Total	2453.093	10902			
Model 3	Regression	91.288	7	13.041	60.159	.000
	Residual	2361.804	10895	0.217		
	Total	2453.093	10902			

Entering the security control variable to the test model 1 did not produced visible effect size $R^2 = .000$ (adjusted $R^2 = .000$) (Table 57). The addition of the compliance control variable to the test model 2. the effect size R^2 =.023 (adjusted R^2 =.023) was observed, with the change effect ΔR^2 = .023. For the full model (test model 3) the effect size R^2 =.037 (adjusted R^2 =.037) was observed, with the change effect ΔR^2 = .014. The changes between models indicates distinctive 1.4% effect by BCM activities on internal service provider cost. Reflecting Cohen (1988), the full model effect sizes small ($R^2 < .02$) observed. This result implies that the practical significance of the test model 3 is questionable, however acknowledging the context where internal service cost accounts in practical level all cost factors, it may not be surprising that BCM activities can explain only a very small portion of depend variable changes.

Table 57. Goodness of fit, stratum 8 internal service provider costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.007	0.000	0.000	0.47437	0.000	0.502	1	10901	0.479
Model 2	.152	0.023	0.023	0.46886	0.023	258,387	1	10900	0.000
Model 3	.193	0.037	0.037	0.46560	0.014	31.713	5	10895	0.000

The p-value ($p < .05$) for tested independent variables indicates that the null hypothesis can be rejected on all independent variables (Table 58). With this evidence it can be conclude that the cost of BCM activities can be determined by five activity types as suggested earlier in the chapter 3.

Table 58. Models' coefficents, stratum 8 internal service provider costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.638	0.007		96.048	0.000
CV1	SLA_security_class	0.006	0.009	0.007	0.708	0.479
Model 2	Constant	0.560	0.008		68.836	0.000
CV1	SLA_security_class	-0.041	0.009	-0.043	-4.317	0.000
CV2	SLA_compliance_class	0.159	0.010	0.160	16.074	0.000
Model 3	Constant	0.507	0.009		53.952	0.000
CV1	SLA_security_class	-0.025	0.010	-0.026	-2.602	0.009
CV2	SLA_compliance_class	0.137	0.010	0.138	13.601	0.000
IV1	BCM_Analyzing*	0.104	0.027	0.037	3.830	0.000
IV2	BCM_Designing*	0.130	0.042	0.030	3.101	0.002
IV3	BCM_Implementing*	0.157	0.015	0.104	10.228	0.000
IV4	BCM_Embedding*	0.045	0.016	0.028	2.827	0.005
IV5	BCM_Maintenance*	0.101	0.010	0.100	9.674	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+11% unit impact (Table 59). In other words, adding BCM activities into the standard IT service managed by internal IT unit, it can be expected ~+11% impact on organizational costs.

Table 59. The proportional impact on stratum 8 internal service provider costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	11%	14%	17%	5%	11%	11%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.4.2 External service provider work costs

The second testing studies external service provider costs stratum 9. Table 60 presents the test results on statistical significance of the presented models on external service provider work costs – stratum 9. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 60. Analysis of variance, stratum 9 external service provider costs.

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Model 1	Regression	22.229	1	22.229	89.668	.000
	Residual	9136.624	36855	0.248		
	Total	9158.853	36856			
Model 2	Regression	99.277	2	49,638	201.927	.000
	Residual	9059.577	36854	0.246		
	Total	9158.853	36856			
Model 3	Regression	227.405	7	32.486	134.031	.000
	Residual	8931.448	36849	0.242		
	Total	9158.853	36856			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .002$ (adjusted $R^2 = .002$) (Table 61). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.011$ (adjusted $R^2 =.011$) was observed, with the change effect $R^2 = .008$. For the full model (test model 3) the effect size $R^2 =.025$ (adjusted $R^2 =.025$) was observed, with the change effect $\Delta R^2 = .014$. The changes between models indicates distinctive 1.4% effect by BCM activities on external service costs. Reflecting Cohen (1988), the full model effect sizes can be considered as small ($R^2 < .02$). However, as discussed earlier with internal service provide case, the context where sample incorporates all cost factors, the small BCM activity effect can be expected, thus the practical significance of the test model 3 can be supported. If the context were different, the significance would likely be disregarded.

Table 61. Goodness of fit, stratum 9 external service provider costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.049	0.002	0.002	0.49790	0.002	89,668	1	36855	0.000
Model 2	.104	0.011	0.011	0.49581	0.008	313.425	1	36854	0.000
Model 3	.158	0.025	0.025	0.49232	0.014	105.726	5	36849	0.000

The p-value ($p < .05$) for tested independent variables indicates that the null hypothesis can be rejected on all independent variables (Table 62). Thus, there is sufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3.

Table 62. Models' coefficents, stratum 9 external service provider costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.792	0.004		218.447	0.000
CV1	SLA_security_class	-0.049	0.005	-0.049	-9.469	0.000
Model 2	Constant	0.693	0.007		103.945	0.000
CV1	SLA_security_class	-0.045	0.005	-0.045	-8.663	0.000
CV2	SLA_compliance_class	0.119	0.007	0.092	17.704	0.000
Model 3	Constant	0.642	0.007		88.874	0.000
CV1	SLA_security_class	-0.029	0.005	-0.029	-5.612	0.000
CV2	SLA_compliance_class	0.115	0.007	0.089	17.180	0.000
IV1	BCM_Analyzing*	0.071	0.014	0.027	5.118	0.000
IV2	BCM_Designing*	-0.115	0.019	-0.031	-5.942	0.000
IV3	BCM_Implementing*	0.152	0.011	0.071	13.388	0.000
IV4	BCM_Embedding*	0.148	0.009	0.089	16.578	0.000
IV5	BCM_Maintenance*	0.078	0.006	0.071	13.000	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the model, the percentage change for one unit (0 to 1) change in independent variables have ~+7% unit impact (Table 63). In other words, adding BCM activities into the standard IT service management, it can be expected ~+7% impact on external service provider costs.

Table 63. The proportional impact on stratum 9 external service provider costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{x}$
Impact %	7%	-11%	16%	16%	8%	7%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.4.3 Summary of organizational resource costs

The null hypothesis H4 tested the BCM activity effect on organizational resource costs. Testing results suggest that the null hypothesis H4 can be rejected (Table 56 and 60). Organizational resources included two independent strata (8 and 9), internal and external service provider perspectives. Distinct values $R^2 = 0.025$ and 0.037 were observed, confirming that the both test model 3 were supported the tolerable effect sizes ($R^2 > 02$). However, the effects that could be explained only by BCM activities, were below the benchmarking with SIM IT survey and with the same exact effect value $\Delta R^2 = 0.014$. It was to be expected that, at least to some extent, different effect sizes would be observed between internal and external organizational costs. This is due to the results of the SIM IT surveys, which state that the majority of organizational IT costs are incurred by the internal IT organization and not by external ones, e.g., (Kappelman et al., 2018).

Considering above observation of identical $\Delta R^2 = 0.014$ value in both strata 8 and 9, it is possible that it was caused the operationalization of the selection variables. Unlike the cost variables that were inherently classified ex-ante by the case company, e.g., as hardware purchasing cost, employee cost, consulting cost or software maintenance cost, the selection variables for organizational resource costs were created during the variable operationalization, in this research. During the operationalization IT service level information about the organizations hosting the business applications was grouped under two variables: internal service provider and external service provider. This data was merged with the cost data base, so that each cost event would have one association only, either with internal or external service provider variables. The external service provider variable consisted of the aggregation of three independent external IT outsourcing and service companies, and the internal service provider consisted of all the remaining data points.

A critical review of strata 8 and 9 Durbin-Watson, normal distributions, tolerance and VIF values, leverage values and descriptive statistics show independent and unambiguous results, so we can exclude that there were duplications of tests. This is also supported by the observation from the test with control variables, where there were different effect sizes. Considering the heterogeneity of the source data and variables, it was not expected that the same effect size would be achieved between complementary variables, i.e., internal vs. external. Considering that all multiple regression model assumptions were fulfilled as an alternative and all other testing results were equivalent, no error was visible in the statistical tests, the result should be accepted even if this does not reflect the distribution of the SIM IT budget between internal and external service provider perspective. Therefore, the practical effect on H4 can be supported.

5.5 IT service design costs (H5)

The research hypothesis H5 ‘there is no IT service design cost difference between IT service with BCM activities and IT service without BCM activities ' was tested on IT service designs cost types. The testing results are based on seven strata: internally owned application costs, externally owned application costs, proprietary customized application costs, commercial customized application costs, commercial configured application costs, regional service delivery and global service delivery costs. Independent variables entered in the test models are presented in the table 23. The descriptive data for the stratum can be found in the appendix 17. The goal for testing on IT service design costs was to observe if the cost of BCM activities would differ between specific service designs e.g. it was assumed that cost effect could be different between commercial business applications and applications that were developed in-house. As an example, in-house developed applications would likely require highly tailored BCM systems than those that have relatively standard and scalable system architectures.

5.5.1 Internally owned application costs

Internally owned applications could be developed in-house or commercial systems. The main difference is to what extend intellectual rights can be used. It can be assumed that services with internally owned applications may have tailored solutions, thus BCM could be also have been designed to integrate into non-standard solutions. Table 64 presents the test results on statistical significance of the presented models on internally owned application costs – stratum 10. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 64. Analysis of variance, stratum 10 internally owned application costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	127.066	1	127.066	282.219	.000
	Residual	24317.515	54010	0.450		
	Total	24444.582	54011			
Model 2	Regression	590.428	2	295.214	668.404	.000
	Residual	23854.154	54009	0.442		
	Total	24444.582	54011			
Model 3	Regression	1133.875	7	161.982	375.265	.000
	Residual	23310.706	54004	0.432		
	Total	24444.582	54011			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .005$ (adjusted $R^2 = .005$) (Table 65). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.024$ (adjusted $R^2 =.024$) was observed, with the change effect $\Delta R^2 = .019$. For the full model (test model 3) the effect size $R^2 =.046$ (adjusted $R^2 =.046$) was observed, with the change effect $\Delta R^2 = .022$. The changes between models indicates distinctive 2.2% effect by BCM activities on internally owned application costs. Reflecting Cohen (1988), the full model effect sizes can considered as small ($R^2 \sim .02$). As observed from previous tests on other strata, the result is on par with other observations. While it can be argued that the practical significance of the model can be supported, like prior results, this can be confirmed when all results are compared in the overall context. This statement can be included to all IT service design cases as result comparison builds the context.

Table 65. Goodness of fit, stratum 10 internally owned application costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.072	0.005	0.005	0.67100	0.005	282.219	1	54010	0.000
Model 2	.155	0.024	0.024	0.66458	0.019	1049,112	1	54009	0.000
Model 3	.215	0.046	0.046	0.65700	0.022	251.801	5	54004	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 66). In the full model (test model 3) the p-value ($p =.897$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable ($p > .05$). In other words, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3. This observation is discussed later in relation with other test observations.

Table 66. Models' coefficents, stratum 10 internally owned application costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.330	0.004		82.129	0.000
CV1	SLA_security_class	-0.097	0.006	-0.072	-16.799	0.000
Model 2	Constant	0.164	0.006		25.408	0.000
CV1	SLA_security_class	-0.099	0.006	-0.073	-17.260	0.000
CV2	SLA_compliance_class	0.218	0.007	0.138	32.390	0.000
Model 3	Constant	0.060	0.007		8.453	0.000
CV1	SLA_security_class	-0.072	0.006	-0.054	-12.629	0.000
CV2	SLA_compliance_class	0.210	0.007	0.132	31.421	0.000
IV1	BCM_Analyzing*	0.141	0.015	0.040	9.227	0.000
IV2	BCM_Designing**	0.003	0.021	0.001	0.129	0.897
IV3	BCM_Implementing*	0.131	0.011	0.053	12.212	0.000
IV4	BCM_Embedding*	0.220	0.010	0.097	22.169	0.000
IV5	BCM_Maintenance*	0.214	0.007	0.143	31.752	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+16% unit impact (Table 67). In other words, in the context of BCM activities into the standard IT service management, it can be expected ~+16% impact on internally owned application costs.

Table 67. The proportional impact on stratum 10 internally owned application costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	15%	0%	14%	25%	24%	16%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.2 Externally owned application costs

Externally owned applications consider any application which intellectual property rights were owned by other than the case company. Table 68 presents the test results on statistical significance of the presented models on externally owned application costs – stratum 11. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 68. Analysis of variance, stratum 11 externally owned application costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	3.081	1	3.081	8.535	.004
	Residual	1052.499	2916	0.361		
	Total	1055.579	2917			
Model 2	Regression	62.505	2	31.253	91.737	.000
	Residual	993.074	2915	0.341		
	Total	1055.579	2917			
Model 3	Regression	95.824	7	13.689	41.506	.000
	Residual	959.755	2910	0.330		
	Total	1055.579	2917			

Entering the security control variable to the test model 1 produced the effect size R^2 = .003 (adjusted R^2 = .003) (Table 69). The addition of the compliance control variable to the test model 2. the effect size R^2 =.059 (adjusted R^2 =.059) was observed, with the change effect ΔR^2 = .056. For the full model (test model 3) the effect size R^2 =.091 (adjusted R^2 =.089) was observed, with the change effect ΔR^2 = .032. The changes between models indicates distinctive 3.2% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes suggest higher than the cut-off value for small (R^2 > .02) thus it can be argued that the practical significance of the model can be supported.

Table 69. Models' goodness of fit, stratum 11 externally owned application costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.054	0.003	0.003	0.60078	0.003	8.535	1	2916	0.004
Model 2	.243	0.059	0.059	0.58368	0.056	174.431	1	2915	0.000
Model 3	.301	0.091	0.089	0.57429	0.032	20.205	5	2910	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 70). In the full model (test model 3) the p-value (p =.240) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable (p > .05). It appears that there is inadequate evidence to conclude that the cost of BCM activities can be determined by five activity types as discussed in the chapter 3. This observation is discussed later in relation with other test observations.

Table 70. Models' coefficents, stratum 11 externally owned application costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.101	0.017		6.099	0.000
CV1	SLA_security_class	-0.065	0.022	-0.054	-2.921	0.004
Model 2	Constant	0.258	0.020		12.898	0.000
CV1	SLA_security_class	-0.016	0.022	-0.013	-0.733	0.464
CV2	SLA_compliance_class	-0.298	0.023	-0.241	-13.207	0.000
Model 3	Constant	0.177	0.022		8.118	0.000
CV1	SLA_security_class	0.016	0.023	0.013	0.682	0.495
CV2	SLA_compliance_class	-0.317	0.023	-0.256	-13.949	0.000
IV1	BCM_Analyzing*	0.221	0.057	0.071	3.910	0.000
IV2	BCM_Designing**	-0.104	0.089	-0.021	-1.174	0.240
IV3	BCM_Implementing*	0.203	0.058	0.062	3.470	0.001
IV4	BCM_Embedding*	0.207	0.036	0.103	5.730	0.000
IV5	BCM_Maintenance*	0.237	0.030	0.148	7.978	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+17% unit impact (Table 71). In other words, adding BCM activities into the standard IT service management, it can be expected ~+17% impact on externally owned application costs.

Table 71. The proportional impact on stratum 11 externally owned application costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{x}$
Impact %	25%	-10%	22%	23%	27%	17%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.3 Proprietary customized application costs

Proprietary customized applications were unique system designs for the case organization to support specific business processes. Table 72 presents the test results on statistical significance of the presented models proprietary customized application costs – stratum 12. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on models 1 and 2 ($p < .05$).

For model 1. supported null hypothesis has little impact on research goals as the focus is on the main model 3.

Table 72. Analysis of variance, stratum 12 proprietary customized application costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	0.106	1	0.106	0.225	.635
	Residual	9635.746	20461	0.471		
	Total	9635.853	20462			
Model 2	Regression	172.941	2	86.471	186.960	.000
	Residual	9462.912	20460	0.463		
	Total	9635.853	20462			
Model 3	Regression	868.395	7	124.056	289.431	.000
	Residual	8767.458	20455	0.429		
	Total	9635.853	20462			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .000$ (adjusted $R^2 = .000$) (Table 73). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.018$ (adjusted $R^2 =.018$) was observed, with the change effect $\Delta R^2 = .018$. For the full model (test model 3) the effect size $R^2 =.090$ (adjusted $R^2 =.090$) was observed, with the change effect $\Delta R^2 = .072$. The changes between models indicates distinctive 7.2% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes suggest higher than the cut-off value for small ($R^2 > .02$). Considering prior observations and the overall context the practical significance of the model can be supported.

Table 73. Models' goodness of fit, stratum 12 proprietary customized application costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.003	0.000	0.000	0.68625	0.000	0.225	1	20461	0.635
Model 2	.134	0.018	0.018	0.68008	0.018	373.691	1	20460	0.000
Model 3	.300	0.090	0.090	0.65469	0.072	324.507	5	20455	0.000

The p-value ($p < .05$). for tested independent variables suggest that the null hypothesis can be rejected on all independent variables (Table 64). This result is sufficient statistical evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed earlier in the chapter 3.

Table 74. Models' coefficents, stratum 12 proprietary customized application costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.114	0.007		15.871	0.000
CV1	SLA_security_class	-0.005	0.010	-0.003	-0.475	0.635
Model 2	Constant	-0.028	0.010		-2.759	0.006
CV1	SLA_security_class	-0.012	0.010	-0.009	-1.278	0.201
CV2	SLA_compliance_class	0.205	0.011	0.134	19.331	0.000
Model 3	Constant	-0.144	0.010		-13.955	0.000
CV1	SLA_security_class	-0.014	0.009	-0.010	-1.515	0.130
CV2	SLA_compliance_class	0.131	0.010	0.086	12.539	0.000
IV1	BCM_Analyzing*	0.316	0.030	0.072	10.689	0.000
IV2	BCM_Designing*	0.153	0.031	0.033	4.922	0.000
IV3	BCM_Implementing*	0.292	0.016	0.129	18.318	0.000
IV4	BCM_Embedding*	0.418	0.017	0.166	24.033	0.000
IV5	BCM_Maintenance*	0.402	0.011	0.248	35.215	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+38% unit impact (Table 75). In other words, adding BCM activities into the standard IT service management, it can be expected ~+38% impact on proprietary customized application costs.

Table 75. The proportional impact on stratum 12 proprietary customized application costs.

Model 3	IV1	IV2	IV3	IV4	IV5	$\bar{X}$
Impact %	37%	17%	34%	52%	49%	38%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.4 Commercially customized application costs

The commercial custom considered applications and systems developed and provided by the external company. Table 76 presents the test results on statistical significance of the presented models on commercially customized application costs – stratum 13. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 76. Analysis of variance, stratum 13 commercially customized application costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	266.718	1	266.718	559.725	.000
	Residual	11076.603	23245	0.477		
	Total	11343.321	23246			
Model 2	Regression	289.489	2	144,745	304.369	.000
	Residual	11053.831	23244	0.476		
	Total	11343.321	23246			
Model 3	Regression	375.952	7	53.707	113.802	.000
	Residual	10967.369	23239	0.472		
	Total	11343.321	23246			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .024$ (adjusted $R^2 = .023$) (Table 77). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.026$ (adjusted $R^2 =.025$) was observed, with the change effect $\Delta R^2 = .002$. For the full model (test model 3) the effect size $R^2 =.033$ (adjusted $R^2 =.033$) was observed, with the change effect $\Delta R^2 = .008$. The changes between models indicates distinctive 0.8% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes can consider visibly small ($R^2 < .02$). Confirmation of practical significance of the model requires discussion on the context of other strata.

Table 77. Models' goodness of fit, stratum 13 commercially customized application costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.153	0.024	0.023	0.69030	0.024	559.725	1	23245	0.000
Model 2	.160	0.026	0.025	0.68961	0.002	47.885	1	23244	0.000
Model 3	.182	0.033	0.033	0.68698	0.008	36.641	5	23239	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 78). In the full model (test model 3) the p-value ($p =.822$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable ($p > .05$). By this there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as discussed earlier in the chapter 3. This observation is discussed later in relation with other test observations.

Table 78. Models' coefficents, stratum 13 commercially customized application costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.538	0.006		86.335	0.000
CV1	SLA_security_class	-0.215	0.009	-0.153	-23.659	0.000
Model 2	Constant	0.455	0.014		33.388	0.000
CV1	SLA_security_class	-0.208	0.009	-0.149	-22.862	0.000
CV2	SLA_compliance_class	0.093	0.013	0.045	6.920	0.000
Model 3	Constant	0.380	0.015		25.470	0.000
CV1	SLA_security_class	-0.186	0.009	-0.133	-19.935	0.000
CV2	SLA_compliance_class	0.093	0.013	0.045	6.940	0.000
IV1	BCM_Analyzing*	0.083	0.025	0.022	3.347	0.001
IV2	BCM_Designing**	0.008	0.035	0.001	0.225	0.822
IV3	BCM_Implementing*	0.142	0.019	0.049	7.345	0.000
IV4	BCM_Embedding*	0.164	0.015	0.075	10.842	0.000
IV5	BCM_Maintenance*	0.100	0.011	0.067	9.508	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+11% unit impact (Table 79). In other words, adding BCM activities into the standard IT service management, it can be expected ~+11% impact on commercially customized application costs.

Table 79. The proportional impact on stratum 13 commercially customized application costs.

Model 3	IV1	IV2	IV3	IV4	IV5	$\bar{X}$
Impact %	9%	1%	15%	18%	11%	11%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.5 Commercially configured application costs

Commercially configured applications consider applications that features are available to any organization, but the features are selected by on the particular business needs. Table 80 presents the test results on statistical significance of the presented models on commercially configured application costs – stratum 14. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 80. Analysis of variance, stratum 14 commercially configured application costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	4.385	1	4.385	11.951	.001
	Residual	2041.254	5564	0.367		
	Total	2045.639	5565			
Model 2	Regression	4.985	2	2.492	6.794	.001
	Residual	2040.654	5563	0.367		
	Total	2045.639	5565			
Model 3	Regression	33.014	7	4.716	13.024	.000
	Residual	2012.625	5558	0.362		
	Total	2045.639	5565			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .002$ (adjusted $R^2 = .002$) (Table 81). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.002$ (adjusted $R^2 =.002$) was observed, with no change effect $\Delta R^2 = .000$. For the full model (test model 3) the effect size $R^2 =.016$ (adjusted $R^2 =.015$) was observed, with the change effect $\Delta R^2 = .014$. The changes between models indicates distinctive 1.4% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes suggest small effect ($R^2 < .02$). Further confirmation needs discussion with the context of other IT service design strata before practical significance of the model can be supported.

Table 81. Models' goodness of fit, stratum 14 commercially configured application costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.046	0.002	0.002	0.60570	0.002	11.951	1	5564	0.001
Model 2	.049	0.002	0.002	0.60566	0.000	1.636	1	5563	0.201
Model 3	.127	0.016	0.015	0.60176	0.014	15,481	5	5558	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 70). In the full model (test model 3) the p-value ($p =.748$) of IV BCM_ Analyzing activity suggest that the variable has no correlation with dependent variable ($p > .05$). Because of this result, there is insufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed in the chapter 3. This observation is discussed later in relation with other test observations.

Table 82. Models' coefficents, stratum 14 commercially configured application costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.203	0.011		18.324	0.000
CV1	SLA_security_class	-0.056	0.016	-0.046	-3.457	0.001
Model 2	Constant	0.211	0.013		16.369	0.000
CV1	SLA_security_class	-0.050	0.017	-0.041	-2.931	0.003
CV2	SLA_compliance_class	-0.022	0.017	-0.018	-1.279	0.201
Model 3	Constant	0.280	0.017		16.424	0.000
CV1	SLA_security_class	-0.091	0.018	-0.075	-4.906	0.000
CV2	SLA_compliance_class	-0.040	0.017	-0.033	-2.341	0.019
IV1	BCM_Analyzing**	-0.014	0.042	-0.004	-0.321	0.748
IV2	BCM_Designing*	-0.376	0.050	-0.105	-7.591	0.000
IV3	BCM_Implementing*	-0.206	0.041	-0.071	-5.055	0.000
IV4	BCM_Embedding*	-0.079	0.031	-0.035	-2.553	0.011
IV5	BCM_Maintenance*	-0.049	0.020	-0.036	-2.453	0.014

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~-13% unit impact (Table 83). In other words, adding BCM activities into the standard IT service management, it can be expected ~-13% impact on commercially configured application costs. Interestingly these seem to be only case where the expected cost effect is negative.

Table 83. The proportional impact on stratum 14 commercially configured application costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	-1%	-31%	-19%	-8%	-5%	-13%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.6 Regional service delivery costs

The case organization had both local operations in different countries and global level process, IT service agreements defined requirements for time and location-based delivery, such like access and availability. This requirement affected on technical setup, such like use of internet technologies, to enable operations either locally or on global level.

Regional services consider applications that were designed to serve country or regional business needs. Table 84 presents the test results on statistical significance of the presented models on regional service delivery costs – stratum 15. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 84. Analysis of variance, stratum 15 regional service delivery costs

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	8.475	1	8.475	25.782	.000
	Residual	1503.930	4575	0.329		
	Total	1512.406	4576			
Model 2	Regression	11.820	2	5.910	18,014	.000
	Residual	1500.586	4574	0.328		
	Total	1512.406	4576			
Model 3	Regression	87.391	7	12.484	40.028	.000
	Residual	1425.015	4569	0.312		
	Total	1512.406	4576			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .006$ (adjusted $R^2 = .006$) (Table 85). The addition of the compliance control variable to the test model 2. the effect size $R^2 =.008$ (adjusted $R^2 =.007$) was observed, with the change effect $\Delta R^2 = .002$. For the full model (test model 3) the effect size $R^2 =.058$ (adjusted $R^2 =.056$) was observed, with the change effect $\Delta R^2 = .050$. The changes between models indicates distinctive 5.0% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes suggest higher than the cut-off value for small ($R^2 > .02$) thus it can be argued that the practical significance of the model can be supported in the context of research.

Table 85. Models' goodness of fit, stratum 15 regional service delivery costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.075	0.006	0.005	0.57335	0.006	25.782	1	4575	0.000
Model 2	.088	0.008	0.007	0.57277	0.002	10.195	1	4574	0.001
Model 3	.240	0.058	0.056	0.55847	0.050	48.460	5	4569	0.000

The p-value ($p < .05$) for tested independent variables indicates that the null hypothesis can be rejected on all independent variables (Table 73). This is sufficient evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed in the chapter 3. Additional observation is that the test model 3 constant shows a greater than the significance level p-value = 0.313 (p > .05). Technically speaking while an insignificant p-value suggests that the constant is not significantly different from 0. i.e., null hypothesis is supported, this does not have practical impact on the models or independent variables results e.g. (Field, 2013).

Table 86. Models' coefficents, stratum 15 regional service delivery costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.137	0.012		11.600	0.000
CV1	SLA_security_class	-0.086	0.017	-0.075	-5,078	0.000
Model 2	Constant	0.098	0.017		5.818	0.000
CV1	SLA_security_class	-0.095	0.017	-0.083	-5.553	0.000
CV2	SLA_compliance_class	0.056	0.017	0.048	3.193	0.001
Model 3	Constant	0.017	0.017		1.009	0.313
CV1	SLA_security_class	-0.097	0.017	-0.084	-5.560	0.000
CV2	SLA_compliance_class	0.028	0.017	0.024	1.645	0.100
IV1	BCM_Analyzing*	0.302	0.043	0.102	6.953	0.000
IV2	BCM_Designing*	0.309	0.132	0.034	2.332	0.020
IV3	BCM_Implementing*	0.332	0.040	0.123	8.273	0.000
IV4	BCM_Embedding*	0.152	0.032	0.070	4.710	0.000
IV5	BCM_Maintenance*	0.262	0.020	0.194	12.986	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+31% unit impact (Table 87). In other words, adding BCM activities into the standard IT service management, it can be expected ~+31% impact on regional service delivery costs.

Table 87. The proportional impact on stratum 15 regional service delivery costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	35%	36%	39%	16%	30%	31%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.7 Global service delivery costs

Global services consists applications that allowed global access and availability regardless of the case company business locations. Table 88 presents the test results on statistical significance of the presented models on global service delivery costs – stratum 16, which is the last test result. According to the analysis of variance, the null hypothesis can be rejected with acceptable probability on all models ($p < .05$).

Table 88. Analysis of variance, stratum 16 global service delivery costs.

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	154.436	1	154.436	311.190	.000
	Residual	26389.876	53176	0.496		
	Total	26544.312	53177			
Model 2	Regression	597.724	2	298.862	612.489	.000
	Residual	25946.588	53175	0.488		
	Total	26544.312	53177			
Model 3	Regression	1213.645	7	173.378	363.927	.000
	Residual	25330.666	53170	0.476		
	Total	26544.312	53177			

Entering the security control variable to the test model 1 produced the effect size $R^2 = .006$ (adjusted $R^2 = .006$) (Table 89). The addition of the compliance control variable to the test model 2. the effect size $R^2 = .023$ (adjusted $R^2 = .022$) was observed, with the change effect $\Delta R^2 = .017$. For the full model (test model 3) the effect size $R^2 = .046$ (adjusted $R^2 = .046$) was observed, with the change effect $\Delta R^2 = .023$. The changes between models indicate distinctive 2.3% effect by BCM activities on IT service cost. Reflecting Cohen (1988), the full model effect sizes can consider small ($R^2 \sim .02$). The practical significance of the model can be supported when the context is accounted.

Table 89. Models' goodness of fit, stratum 16 global service delivery costs.

	R	R^2	Adj.R^2	Std. Error	ΔR^2	F Change	df1	df2	Sig. F Change
Model 1	.076	0.006	0.006	0.70447	0.006	311.190	1	53176	0.000
Model 2	.150	0.023	0.022	0.69853	0.017	908.476	1	53175	0.000
Model 3	.214	0.046	0.046	0.69022	0.023	258.568	5	53170	0.000

The p-value (Sig.) for tested independent variables indicates that the null hypothesis can be rejected on all but one independent variable (Table 90). In the full model (test model 3) the p-value ($p = .841$) of IV BCM_ Designing activity suggest that the variable has no correlation with dependent variable (p > .05). With this result, there is insufficient statistical evidence to conclude that the cost of BCM activities can be determined by five activity types as proposed in the chapter 3. This observation is discussed later in relation with other test observations.

Table 90. Models' coefficients, stratum 16 global service delivery costs.

		B	Std. Error	β	t	Sig.
Model 1	Constant	0.332	0.004		77.897	0.000
CV1	SLA_security_class	-0.108	0.006	-0.076	-17.641	0.000
Model 2	Constant	0.171	0.007		25.108	0.000
CV1	SLA_security_class	-0.109	0.006	-0.077	-17.983	0.000
CV2	SLA_compliance_class	0.213	0.007	0.129	30.141	0.000
Model 3	Constant	0.057	0.008		7.561	0.000
CV1	SLA_security_class	-0.076	0.006	-0.053	-12.468	0.000
CV2	SLA_compliance_class	0.205	0.007	0.124	29.239	0.000
IV1	BCM_Analyzing*	0.137	0.016	0.036	8.438	0.000
IV2	BCM_Designing**	-0.004	0.022	-0.001	-0.200	0.841
IV3	BCM_Implementing*	0.133	0.011	0.052	11.717	0.000
IV4	BCM_Embedding*	0.253	0.010	0.108	24.320	0.000
IV5	BCM_Maintenance*	0.225	0.007	0.143	31.258	0.000

* Rejected null hypothesis
** Supported null hypothesis

According to corrected (Halvorsen & Palmquist, 1980) measurement of unstandardized coefficients (B), when the reference group (standard IT service) is switched to the comparison group (IT service with BCM) in the test model 3, the percentage change for one unit (0 to 1) change in independent variables have ~+17% unit impact (Table 91). In other words, adding BCM activities into the standard IT service management, it can be expected ~+17% impact on global service delivery costs.

Table 91. The proportional impact on stratum 16 global service delivery costs.

Model 3	**IV1**	**IV2**	**IV3**	**IV4**	**IV5**	$\bar{X}$
Impact %	15%	0%	14%	29%	25%	17%

Note: As each activity has been measured as a dummy variable (1 or 0), regression coefficients represent difference between two groups, not between each activity class.

5.5.8 Summary of IT service design costs

The hypothesis 5 (H5) tested the correlation between IT service design costs and BCM activities. Based on seven tests with consistent results, it can be suggested to reject the null hypothesis H5 (Table 64, 68, 72, 76, 80, 84 and 88). The first service design perspective, application ownership effect sizes $R^2 = 0.046$ for internally owned and $R^2 = 0.089$ for externally owned applications suggest that the main model with control variables can measure the proportional value between dependent and independent variables, exceeding the small effect cut-off value ($R^2 > .02$) (Ellis, 2010). According to ΔR^2 results it can be suggested that BCM activities can explain 2.2% of internally owned application costs and 3.2% of externally owned application costs. Organizations may pursue more cost-effective BCM solutions when there are no limiting factors such as system versions or configurations that are required to be used by the owner of the technology. The non-standard configurations were evident from those IT continuity plans prepared by the IT service teams of the case company for internally owned applications. When applications are externally owned, license terms may require the use of specific technology standards and support services to secure application owner liabilities. Consequently, less expensive configurations cannot be applied when pursuing IT cost optimization.

The second design perspective considers differences between application customizations. BCM activities seem to explain 7.3% ($\Delta R^2 = 0.072$) of proprietary customized application costs, while the effect for commercially customized applications was 0.8% ($\Delta R^2 = 0.008$) and for commercially configured applications 1.4% ($\Delta R^2 = 0.014$) only. It is possible that internally developed applications have unique design properties that require tailored and novel BCM solutions. Such unique solutions' lifecycle costs could be higher than those of applications using industrial standard designs, including in BCM. Commercial application customization and configurations may benefit from prior integration projects and offer standardized BCM solutions, so the cost effect is lower than with proprietary applications. During the discussions with the case company representatives and document reviews, this became clear in the example of several business applications for the manufacturing process, which were unique even compared to other industry players. This meant that, e.g., server fault-tolerance and data backups had unique system configurations. When comparing application ownership and customization results, one would assume that the same pattern exists, i.e., internal application designs generate either higher or lower cost than external ownership and customization.

The third and final design perspective looks at differences in the delivery of application services, i.e., whether the application was designed to reach global end-users or whether it was designed for use in one or a few regions, e.g., countries. According to the results, BCM activities could explain 5% ($\Delta R^2 = 0.050$) of the cost applications designed for regional use. With reference to applications that were designed for global reach, the BCM activities could explain 2.3% ($\Delta R^2 = 0.023$) of costs. Given the globally accessible IT services of the case company, these were in most cases designed form the outset as high availability systems, e.g., with multiple internet service providers, multi-data center operations capability and high reliability technologies like multiprocessor and hard disk capabilities. These types of solutions are often used in BCM planning, e.g., (Bajgoric, 2012). Since regionally accessible applications do not have the same high availability designs, it is possible that BCM solutions could be considered as an additional feature explaining why BCM activities correlate with a higher cost effect.

5.6 The summary and inference of the results

In relation to main research question *how to determine the cost of BCM activities in IT services*, it was suggested that the cost of BCM could be observed by measuring correlation between BCM activities (list 3) and IT service costs. Three sub-questions were defined to explore specific perspectives to the cost determinants in IT services.

List 3. BCM activities

$$a_1 = Understand\ the\ organization = design\ activity\ (IV1)$$
$$a_2 = Determine\ the\ business\ continuity\ strategy = \ analyzing\ activity\ (IV2)$$
$$a_3 = Develop\ and\ implement\ the\ plan = implementing\ activity\ (IV3)$$
$$a_4 = Embed\ business\ continuity\ into\ organizatio = \ embedding\ activity\ (IV4)$$
$$a_5 = Exercise, test\ and\ maintain\ the\ plan = \ maintenance\_activity\ (IV5)$$

The first sub-research question considered if BCM activity cost variation can be observed from the case company the overall IT service costs. The null hypothesis (H1) test included human and technology resource cost factors as they were assigned to the IT service innately by the case company. **According H1 $\Delta R^2 = 0{,}026$, it can be stated that *~2,6% of the IT service cost variation can be explained by BCM activities (SRQ1)* (Table 92).** If we think about IT resources at large, we can agree that H1 test provides incomplete view on costs due missing resource type – organizational resources. This does not degrade the value of test for two reasons. First, it confirms that the BCM activity cost effect can be observed, even not all factors are included. Second, it also supports the idea that inclusion of all resource factors can improves the test models output as it can provide more comprehensive view on costs. This can be seen when we compare H1 ΔR2 = 0,026 with average from H2, H3 and H4 ΔR2 = 0,035 (Table 92).

The second sub-question (SRQ2) considered the correlation between BCM activities and the cost of different IT resources types discussed, e.g., Ross (1996) and Saunders (2016). ***Taking into account all three hypotheses, the human (H2),***

technological (H3) and organizational (H4) resource perspectives, it can be concluded that on average 3.45% (1% to 10.5%) of the IT cost variation in IT resource types can be explained by the BCM activities (SRQ2) (Table 92).

Hypothesis 5 was built on the assumption that IT service design, namely application design, can regulate the conditions for BCM implementation in an IT service. Therefore, BCM activity costs could vary between different designs, just as it was observed between different resource cost types. The null hypothesis was tested with seven independent strata grouped into three complementary perspectives. The first testing concerned the ownership of an application, the second the application customization and the last the distribution of services. ***When all three perspectives and seven strata to H5 are accounted, it can be stated that on average 3.2% (0.8% to 7,2%) of the IT cost variation in the different IT service designs can be explained by BCM activities (SRQ3) (Table 92)***.

Considering overall results to the main research question *How to determine the cost of BCM activities in IT services?* it can be argued that for statistical testing BCM activities can be used as cost determinants on IT resources and in return IT resources are cost drivers on BCM activities. This can be stated given the limitations of the research scope and available data used in the tests. Table 92 aggregates all results into the single table by research questions, name of strata, null-hypothesis results and the both effect sizes – the test model 3, that accounts both control and independent variables and the BCM effect size that measure only BCM activities effect on IT service costs. In addition, the table lists each independent variable which correlation with IT costs was inconclusive based on the null hypothesis test.

Table 92. Analysis results summary.

Research questions (Hypothesis#)	**Strata**		**Null hypothesis BCM on costs**	**Test model 3 effect size (Adj.R^2)**	**BCM effect size (ΔR^2)**	**Inconclusive BCM activity type**
SRQ1 (H1)	1.	All IT service costs	Rejected	0.047	0.026	Designing
SRQ2 (H2)	2.	Internal work costs	Rejected	0.042	0.027	Analyzing Designing
	3.	External work costs	Rejected	0.014	0.010	Not observed
SRQ2 (H3)	4.	Software purchasing costs	Rejected	0.071	0.033	Designing
	5.	Software maintenance costs	Rejected	0.091	0.045	Designing
	6.	Hardware purchasing costs	Rejected	0.057	0.028	Analyzing
	7.	Hardware maintenance costs	Rejected	0.157	0.105	Not observed
SRQ2 (H4)	8.	Internal service provider costs	Rejected	0.037	0.014	Not observed
	9.	External service provider costs	Rejected	0.025	0.014	Not observed
SRQ3 (H5)	10.	Internally owned application costs	Rejected	0.046	0.022	Designing
	11.	Externally owned application costs	Rejected	0.089	0.032	Designing
	12.	Proprietary customized application costs	Rejected	0.090	0.072	Not observed
	13.	Commercially customized application costs	Rejected	0.033	0.008	Designing
	14.	Commercially configured application costs	Rejected	0.015	0.014	Analyzing
	15.	Regional service delivery costs	Rejected	0.056	0.050	Not observed
	16.	Global service delivery costs	Rejected	0.046	0.023	Designing

There are three considerations that are important for understanding the above presented results in this research. The first consideration is the statistical significance in terms of null-hypothesis testing to observe if an effect exists between variables – it answers to the questions if the results were due to random chance or real phenomenon (Field, 2013). There are several statistical tests for multiple linear regression analysis, the interpretation of which depends on the type of variables and the particular research design – such as the use of dummy variables with log-transferred data (Tabachnick & Fidell, 2014; Field, 2013). The research question of "how to determine the cost of BCM in IT services" assumed that the five different null hypotheses could be validated by statistical testing of the theoretical aspects of the suggested model. Statistical testing involves two inherent risks – rejection of a true null hypothesis, a type I error, and non-rejection of a false null hypothesis, a type II error (Tabachnick & Fidell, 2014; Field, 2013). The risk of a wrong decision can be mitigated by adopting a probabilistic measurement of the level of significance, i.e., the alpha (α) level and the p-value of the test statistic. To confirm or reject the statistical significance of the null hypothesis, the confidence level of 95%, which corresponds to the alpha level (1 – 0.95) 0.05, was set as the threshold for each strata test in the SPSS software used in the research (Field, 2013). Beside the model level interpretation, statistical significance testing, i.e., alpha to the p-value, provides information on whether there is an effect or correlation between each BCM activity and IT costs (Ellis, 2010). Low p-values (< .05) show an existing correlation between dependent and independent variables, while higher values suggest the absence of such a correlation. Confirming the null hypothesis at any level of the independent variable may lead to the assumption that this variable should be excluded from the theoretical cost of BCM activity model. Inconclusive observations of the independent variables have been presented in the chapter 5.6, Table 92.

The second consideration is the practical significance of the results – referring to the magnitude of the effect between the variables and answering to the question, how much of the cost difference is between IT services without BCM vs. IT services with BCM (Ellis, 2010). One of the primary focuses on this research was to observe the adjusted R^2 and effect size changes between control variables and independent variables. Effect size results indicate the proportion of variance in the dependent variable explained by the independent variable, or in other words, the cost effect caused by the BCM activities on IT costs (Tabachnick & Fidell, 2014; Field, 2013). In multiple regression analysis, the practical significance of the model can be measured by the effect size R-squared (R^2), which expresses the percentage of variation in the dependent variable explained by the independent variable, ranging from 0 to 100% or 0 to 1 (Ellis, 2010). $R^{2.}$ Also known as a coefficient of determination, or a coefficient of multiple determination for multiple regression, measures how well observations are fitting the linear regression line (Ellis, 2010). In the various research fields, it is widely assumed that a higher R^2 or its modifications, e.g., adjusted $R^{2.}$ Expresses goodness of fit of the data and thus explains the phenomenon better than the low effect size (Ellis, 2010). However, what can be considered as a low effect size depends on the context and field of study (Ellis, 2010). Therefore, a researcher must understand what can be considered a relevant effect size in relation to the real-world phenomenon (Ellis, 2010). According to Ellis (2021), effect sizes can be interpreted through the three Cs – context, contribution, and Cohen.

In real world, a small event may trigger a big outcome (Ellis, 2010). It can change the probability of a larger event or small effects may become important when they are accumulating into larger effects (Ellis, 2010). In individual cases, the cost effect of BCM activities may seem insignificant for the budget of one or a few IT services, especially in the context of a large organization. However, when this effect accumulates over the hundreds of IT services during their lifecycle, as in the case company, it can become an influential factor to consider in the context of IT service management when deciding how to allocate resources to BCM in relation to other IT management activities. From the point of view of contribution to knowledge, the key question is: how do the findings differ from previous research and what does this difference between observations mean in practice? As discussed earlier, BCM costs, especially pre-incident costs, are not a largely studied subject, so the contribution to prior knowledge based on a comparison with other research work is a challenge. As we lack the direct point of reference, the contribution can be considered in a broader but still relevant context of IT costs. This research lean on the prior knowledge in relation to the Society for Information Management IT Issues and Trends annual surveys, where applicable (Kappelman et al., 2021).

In the absence of context or the point of reference for the contribution, the effect size can be evaluated by using Cohen's (1988) effect size model (Cohen, 1992; Salkind, 2007; Ellis, 2010). The effect size measures can be expressed by reference values of the standard deviations (d), where the effect sizes 0.2 imply a small effect size, 0.5 a medium effect size, and 0.8 a large effect size. The Cohen's model provides corresponding effect size classes for R^2 values that allow effect size evaluation when the selected method is a multiple regression analysis. Cohen's model has been largely accepted in social science research, e.g., in information systems Baroudi (1989) and McSwain, (2004). The original purpose of the Cohen's model was to offer a comparable reference model to eliminate arbitrary benchmarks. However, focusing exclusively on the Cohen's model can lead a researcher to limit the real significance of the findings (Ellis, 2010). In an ideal world, researchers would normally interpret the practical significance of their research results by placing them in a meaningful context or evaluating their contribution to knowledge. When this is problematic, Cohen's benchmark values presented in the may serve as a last alternative.

In this research, the effect sizes were interpreted through the context of IT costs. Even if BCM activities may have a small cost effect in the context of a single IT service, this cost can accumulate into a larger effect given the multi-year lifecycle of an IT service and taking into account the fact that organizations usually have more than one IT service. In another words, a randomly determined small value of .02 effect size might be insignificant in the context of single service. However, if we imagine 100 IT services running in parallel, each with a 2% cost effect over its multiyear lifecycles, it is fair to argue that a small effect can have practical significance in a larger context. Given the contribution to prior knowledge, this research uses prior findings from IT cost surveys to reflect if the research results are within credible margins in relation to the real world. Cohen's (1988) reference values were also mentioned in this research to provide perspectives on theoretical effect size benchmarking (Ellis, 2010).

The third consideration concerns the interpretation of the regression coefficients, which are estimates of the unknown population parameters indicating the relationship between a dependent variable and each independent variable (Field, 2013). This is an important topic as it can serve the future reproductions of this research design. Unstandardized beta coefficients (B) are estimated parameters on the same scale on which the dependent variable was measured, so they can be considered a real representation of the BCM activity costs in this research (Field, 2013). Standardized beta coefficients (β) are normalized so that different scale coefficients can be interpreted on equal ratio. Since all independent variables in this research were measured with the same scale, 1 or 0, standardized beta coefficients are not discussed in this paper. The focus is on the regression coefficients of the independent variables, especially those with statistical significance ($p <.05$), which demonstrate a correlation between BCM activities and IT costs.

Regression coefficients express the nature of correlation between variables – if a value of a continuous independent variable changes by one unit, the value of a continuous dependent variable is expected to change relatively, e.g., price and cost (Field, 2013). This principle applies when both dependent and independent variables are continuous variable types. However, when independent variables are dummy variables, like in this research, the relation has a different interpretation. The coefficient of a dummy variable measures the discontinuous effect of the presence of the factor, in this case BCM activity, on a dependent variable represented by the dummy variable (Halvorsen & Palmquist, 1980; Hardy & Reynolds, 2004). In other words, when dummy variables are used in statistical testing, the value of the slope coefficient (B) is the difference between the two groups – the reference and comparison groups. In this research, we compared IT services with BCM activities, denoted as *IT service with BCM* and coded as 1 to the standard IT services that have no BCM activities, denoted as *standard IT service* and coded as 0. In practice, the regression coefficient stands for the difference in IT service costs with BCM costs compared to standard IT service costs. Since BCM activity costs are added to the constant (mean value of the standard service), the difference between the constant and unstandardized B coefficient can be interpreted as the cost of BCM. The interpretation of the unstandardized coefficients (B) when the independent variables are dummy variables and the dependent variable is continuous and log-transferred, as in this research, requires an additional correction in the calculations. When the state of the dummy coded independent variable X changes from 0 to 1, the percentage impact of the independent variable on the dependent variable can be calculated according to the following rule $100(\exp(B) - 1)$ (Halvorsen & Palmquist, 1980). The result in percentages informs about the proportional difference between groups, that is the magnitude of the cost of BCM in IT services.

6 Discussions of the results

6.1 BCM activity cost model

The BCM activity cost model (Figure 12) hypothesized that BCM activities are the cost determinants on IT resources and in return IT resources are cost drivers on BCM activities.

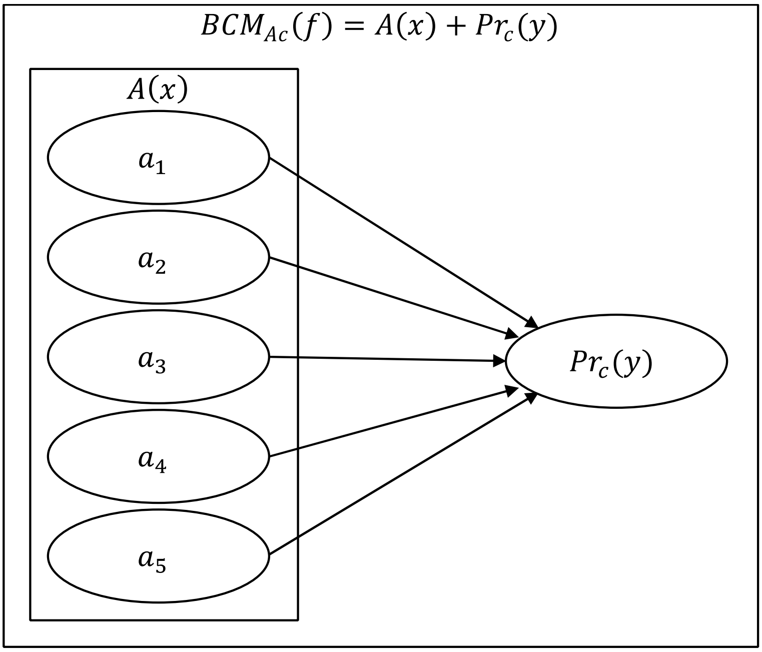

Figure 12. The BCM activity cost model.

As presented in the result chapters both the statistical and practical significance of the BCM activity cost model can be supported. While the observed effect sizes were small, they were within the acceptable range, especially in the context of the IT service costs. According to the results, what was considered as theoretical BCM activities, seems to explain part of the IT services costs, albeit fluctuating due to the class differences of the dependent variable cost types. Although we can conclude that both statistical and practical significance for the test model 3, that reflects the theoretical BCM activity cost model, was supported in all strata, the question remains as how each independent variable entered the test models correlated with the dependent variables.

The five BCM activity variables were suggested based on the literature (Table 1), articulated in a formal expression (Equation 5) and operationalized (Table 20) for statistical testing (Table 23). The p-value (Sig.) for two independent variables tested indicated missing correlations (p > .05) with dependent variables – BCM analyzing and designing activities. The missing correlation for the BCM analyzing activity variable was observed in 3 out of 16 strata tested. A more detailed review of the individual cases did not reveal any systemic pattern that could explain the missing correlations. For this reason and because of the overall low observation from the strata, there is no particular reason to exclude this BCM analysis variable from the proposed model. However, the tests show that in half of the cases, 8 out of 16 observations, the BCM designing activity variable had no correlation with dependent variable (Table 93).

Table 93. BCM activity correlations.

Research questions (Hypothesis#)	Strata		Inconclusive BCM activity type	Sig.
SRQ1 (H1)	1.	All IT service costs	Designing	0.737
SRQ2 (H2)	2.	Internal work costs	Analyzing Designing	0.211 0.206
	3.	External work costs	Not observed	-
SRQ2 (H3)	4.	Software purchasing costs	Designing	0.173
	5.	Software maintenance costs	Designing	0.293
	6.	Hardware purchasing costs	Analyzing	0.605
	7.	Hardware maintenance costs	Not observed	-
SRQ2 (H4)	8.	Internal service provider costs	Not observed	-
	9.	External service provider costs	Not observed	-
SRQ3 (H5)	10.	Internally owned application costs	Designing	0.897
	11.	Externally owned application costs	Designing	0.240
	12.	Proprietary customized application costs	Not observed	-
	13.	Commercially customized application costs	Designing	0.822
	14.	Commercially configured application costs	Analyzing	0.748
	15.	Regional service delivery costs	Not observed	-
	16.	Global service delivery costs	Designing	0.841

The possible reason for missing correlations could be caused by quality issues in the research data. It is possible that the IT service teams underreported this activity and fewer data points would cause the missing correlation. It can be assumed the entire research data was subject to human errors, which could be the reason for the observation. However, the assumption that only one activity class could have been systematically misreported is not a plausible explanation considering the observation period 2006-2012 and the number of independent units of analysis in the scope.

The other explanation for missing correlations is that the BCM designing activity is either 1) an activity type that does not incur observable costs or 2) the activity is combined with preceding or subsequent activities and thus not included in IT service team reports and 3) BCM designing activity would occur most of the time outside of the IT service teams e.g. by another business team. Considering the first alternative, this explanation could be possible since we can observe that in half of the strata the independent variable does show correlations. Apart from that, there seems to be no pattern that would point to the root cause. For example, if we observed a lack of correlation in the hardware and software maintenance strata, but not in the purchasing strata, we could assume a cost category-based correlation as a reason. This kind of pattern was not observed.

Considering the second alternative, the inclusion with another independent variable could be explained by overlapping or merged tasks. This means that the IT service teams carried out analysis and planning activities one after the other. IT service teams may not have experienced any differences at the task level – such as between business requirements and system requirements. Consequently, they may have reported BCM designing tasks in Analyzing or Implementing activities. Table 15 shows that the BCM designing activity datapoints account for 3% of all observations (n=221 out of 7861), which is the smallest account of all variables. This supports the idea that some teams may have reported the designing activity under a different activity type. Fewer than other variables are considered in absolute terms, but the multiple regression analysis based on dummy variables measures each variable independently. In practice this would mean that existing correlation should have been observable, at least when stratum 1, all IT service costs, were tested, even with the sample size of 221. Despite of independent testing, it is possible that the small sample size caused the absence of the correlation. The third alternative explanation assumes that the BCM designing activity was done by other teams than IT service teams. This could be a very good reasoning; however, IT service teams were responsible of all activities for their IT service. Especially system and service designs require the ownership of the IT service team as they had the knowledge of the whole environment. While it is known that the case company IT service teams did use external services and did collaborate other internal teams, the responsibility of the designs was in the team.

Because of this, the third explanation is not believable reason for missing correlation of the BCM design variable.

Missing correlations of the design variable seem to be random, i.e., there is no apparent reason explaining why this independent variable is missing in some strata. Reflecting upon this, it is inconclusive to argue that the hypothetical BCM activity model consists of five independent activities. However, the test model 3 is supported by including at least four independent activities. There also seems to be a correlation between IT service designs and BCM activities, as we observed a change in BCM costs by IT service designs. As discussed earlier, IT service design can be considered as an upstream cause of BCM. As testing the moderator effect of IT service design was not included in the research scope, it was excluded from the testing. Categorically successful test results indicate that there is a correlation between IT service design and BCM activities, so testing the moderator effect should be embraced in future research. Another option would be to test BCM costs by design variables, with each design type operating as an independent variable.

6.2 Reflecting results to reality

From the outset, the expectation was that BCM activities would create additional costs for the IT organization and its IT services implementing the practice. Intuitively thinking and reflecting, e.g., activity-based costing (Maiga, 2015), the assumed cost effect was taken as an obvious as in real life, costs are associated to all operations in all organization types. Therefore, the legitimate question is why this research would matter at all. It may be true that for every action there is some form of cost, but what if we know the factors behind the phenomenon? If we think about the logic that spending on information security should not exceed the point of marginal benefit, it can be assumed that the cost of BCM should not be higher than the anticipated losses (Gordon & Loeb, 2002). Another consideration is business development in relation to IT, IT costs can be significant sources of organizational costs (Brynjolfsson & Yang, 1996) and as surveys from recent years show, cost management remains one of the top 10 IT management issues (Kappelman et al., 2021). Interestingly, in the same survey, the importance of business continuity was higher than in previous years, likely because of the pandemic in 2020. Given that there was little or almost no prior knowledge of the cost of BCM implementation and the opportunity to develop a workable assessment methodology, the rationale for this research was appropriate. As a result, the BCM activity cost model was developed and tested statistically.

After testing the analysis of variance, it can be confirmed that all null hypotheses are rejected due to the consistent results on all strata (Table 92). Rejecting the null hypothesis would statically indicate that the results are not random observations, but that the proposed independent variables have an impact on the dependent variable and thus can be used to measure BCM activity costs. Although this is a very encouraging result, there are some limitations when discussing the outcome. Large samples, as in this case study (Appendix 17), can provide more reliable results, but very often inherently can lead to statistically significant results by default (Hair, 2010; Tabachnick & Fidell, 2014). For this reason, the statistical significance of the results can be considered a necessary but not a sufficient condition for a conclusive interpretation of the results, thus needs to discuss in parallel with practical significance results (Hair, 2010; Tabachnick & Fidell, 2014). The Table 92 shows the practical significance of the results for the adjusted R^2 on the test model 3 with control variables and the ΔR^2 for the effect explained by BCM activities only. Calculating the adjusted R^2 for all strata yields an average value of 0.057 (min. 0.014, max. 0.157), which explains ~5.7% of the cost variations when the control variables were included in the model. When BCM activities were integrated into the test model 3. in the observed change the difference between models 2 and 3 was average $\Delta R^2 = 0.033$ (min. 0.008, max. 0.105). This suggests that BCM activities would explain ~3.3% (0.8% - 10.5%) of all reported costs, implying that the remaining 96.7% (99.2 – 89.5%) of effects can be explained by the other factors in the case company IT operations.

A look back to the Table 92 shows that although there are deviations between all estimates, these can be considered small effects when Cohen's benchmarking was used. A small effect size indicates a real effect, but its practical significance can be questionable without the right context (Ellis, 2010). Considering the full range of cost factors, such as different ITIL processes, e.g., (Agutter, 2019) or sources of costs, e.g., (Gerlach et al., 2002), it is not unexpected that BCM activities account only for a small portion of the IT service costs. This information can encourage IT organizations to consider wider acceptance of BCM as, unlike believed, it may not inherently be a high cost activity. As discussed in chapter 2.6, the shortage of broader research regarding IT spending on BCM points to finding an alternative solution to reflect what can be considered a plausible effect size of BCM activity costs in IT services. The solution in this research is to discuss the size of the BCM cost effect in the context of similar or closely coupled activities. As BCM is discussed as part of information security management by some researchers (Silic & Back, 2014) or presented in the same research contexts, e.g., (Dey, 2011; Järveläinen, 2012; Shaw & Smith, 2010), reflecting on information security or cybersecurity spending can provide the point of reference for discussing the relative accuracy of the observations.

To discuss whether the predicted effect sizes and proportional cost difference between BCM and non-BCM IT services reflect a real phenomenon, the results were discussed using two IT surveys that contain the point of reference in the same time periods as the sample of this research 2006 – 2012. The Ponemon Institute's global surveys show the average share of IT budgets spent on IT security from 2005 to 2017 (Ponemon Institute; Thales Group, 2018). This report provides a means to compare the effect size of BCM activity cost with IT security costs and discuss if the research results are within the plausible range for assuming practical significance. The Society for Information Management (SIM) studies on IT issues and trends provide multi-year research of IT topics such as IT budget allocations, e.g., (Luftman et al., 2008; Luftman, 2009, 2012; Kappelman et al., 2014, 2018, 2021). SIM IT papers provide insight into the same cost classifications used in this research, such as employee, hardware and software costs, as well as mutually non-exclusive categories, as for example outsourcing and cybersecurity, (Kappelman et al., 2021). However, there are some considerations about the extent to which SIM IT papers can be used due to inconsistencies with data. A closer look to SIM IT papers shows IT budget data has only been collected in a standardized way since 2009. Even after the normalized survey, cost definitions were gradually changed to reflect the changes in the IT industry. Therefore, direct comparison of years, e.g., 2006 and 2020, may lead to misinterpretations.

For this research though, discrepancies are not a big issue. First of all, the cost factors used for this research discussion have not changed too much over time. Secondly, the relative and rounded-up estimates for this research provide reasonable reference points to discuss how the incremental costs of BCM activities differs from what is considered a general trend, e.g., that employee cost factors are likely to consume most of the IT budgets. The cost factors corresponding to the cost categories of this research have been compiled in appendix 18. Appendix 18 also consists of cyber and IT security budget allocation data. To facilitate discussion, Figure 13 visually shows the distribution of IT budget allocations, covering both human and technology resource costs as well as cyber and IT security cost allocations.

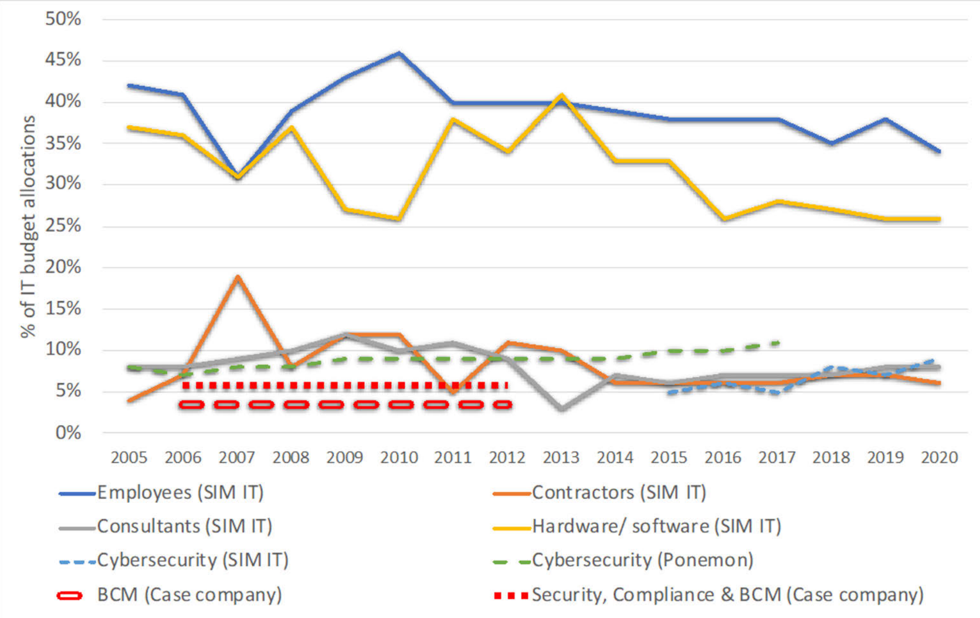

Figure 13. IT budget allocation surveys 2005 - 2020 & reference lines from the case company.

The comparison of materialized budget allocations, like presented in the figure 13, can show whether the BCM activity costs by cost categories show the same relative difference as in real observations, e.g., the relative difference between human and technology resource costs. According to SIM IT surveys, cybersecurity budgets range from ~5% (2015) to ~9% (2020) (Appendix 18). The Ponemon Institute's global multi-industry surveys found that the percentage of total IT budgets spent on IT security from 2005 to 2017 ranged from ~7% to 11% (Ponemon Institute; Thales Group, 2018). Despite the point that the survey dates of SIM IT issues and trends do not fully overlap with the sample time span of this research and the comparison of security spending with BCM costs can be only indicative, using these for framing the case can provide an interesting view. Calculating the average BCM cost from the strata 2-9 (Table 92) yields ~3.5% (1% - 10.5%), which indicates the average BCM activity cost effect size of the case company. Calculating the average cost of security, compliance and BCM from the strata 2-9 (Table 92) presents ~5.8% (1.4% - 15.7%) cost effect. Comparisons of the case study results to the prior literature survey results suggest that the case company security, compliance and BCM costs, seem to be lower than average when comparing to the security costs from different industries. This result indicates that the research data and the used method seem to present realistic results. Therefore, it can be derived that the presented BCM costs reflects reality on acceptable level. Comparison between SIM IT, The Ponemon Institute and this research results can be seen in the figure 13. While a single case study results cannot be generalized to all or even fewer organizations, this comparison suggests that the case company BCM costs appear to be less than information security costs.

Although the indirect statistical cost results of this research are not directly interchangeable with the direct cost reports or surveys, some observations can be made. The differences between BCM and information security cost effects are visible. While we may not know how each organization calculates its information security costs, it can be assumed that these costs include a large number of activities, technologies and security services, e.g., (Böhme, 2013). It may be considered that some responders in the e.g. SIM IT surveys also include BCM costs in their answers. This can explain why, categorically, information security costs can be somewhat greater than BCM costs in IT services (Figure 13). It is important to note here that despite the obvious differences in the presentation of the security budgets and the prediction of BCM activity cost, the effect size is not significantly different from the mean value of the security budgets – about ~5 percentage points. If the effect size had been relatively very small or very high, the contextual reasoning for the effect sizes would not have worked. It can be argued that the proposed methodology and model provided the valid results for discussing the practical effect of BCM activities on IT service costs – that is, it appears to measure what it claims to measure in terms of context.

6.3 The added cost of BCM activities

As discussed above, the proposed model for measuring the cost of BCM appears to meet both the statistical and practical minimum significance criterion in relation to the context of IT costs and is confirmed by Cohen' benchmark (Ellis, 2010), which can be considered as results at least at an acceptable level. The observed effect size provides information on how much of the cost variations can be explained by BCM activities of the target population – the IT services in the case company. However, it does not inform about the extent of the proportional cost difference between the groups – standard IT services and those integrating BCM in IT service management. In order to show the proportional difference between the groups, regression coefficients of the independent variables were presented as mean percentage in the Table 94. Table 94 is divided into two parts, the percentage impact of the independent variable on the dependent variable above the average from all strata and the percentage effect below the mean value.

Table 94. The mean cost of BCM activities on IT service by cost categories

Cost category	Strata		Avg. increase of cost
Technology resource cost	7	Hardware maintenance costs	65%
Technology resource cost	6	Hardware purchasing costs	44%
Technology resource cost	4	Software purchasing costs	38%
IT service design cost	12	Proprietary customized application costs	38%
IT service design cost	15	Regional service delivery costs	31%
Technology resource cost	5	Software maintenance costs	30%
Mean value	**0**	**Average cost impact**	**27%**
IT service cost	1	All IT service costs	18%
IT service design cost	11	Externally owned application costs	17%
IT service design cost	16	Global service delivery costs	17%
IT service design cost	10	Internally owned application costs	16%
Human resource cost	2	Internal work costs	12%
Organizational resource cost	8	Internal service provider costs	11%
IT service design cost	13	Commercially customized application costs	11%
Organizational resource cost	9	External service provider costs	7%
Human resource cost	3	External work costs	6%
IT service design cost	14	Commercially configured application costs	-13%

The average cost increase was ~+27% due to BCM integration into the IT services management routine. The pattern between higher and lower than the mean value shows the concentration of technological resource costs above the mean value, while human resource and organizational costs are well below the mean value. This result follows IT SIM cost trends, where human resource costs account for an average of 18% (employees, consultants and contractors) and technology resource costs account for 28% (hardware/ software/ network) of IT budget allocations. This can be expected as from 2007 to 2012 IT disaster recovery solutions ranked among the top 15 largest IT investments, being in the top 6 for four consecutive years (Kappelman et al., 2013). However, the SIM trends have a difference of ~10 percentage points, while the BCM case has an average difference of 35 percentage points difference between human (avg. 9%) and technology (avg. 44%) resource costs. It can be said that technology resource costs are overrepresented in the BCM activity costs when compared to the survey findings of what are expected IT cost levels (Appendix 18). It is possible that IT service teams did not increase the team size significantly to respond new continuity technologies support needs. Instead, continuity knowledge was embedded into the IT service team's routines. It is also possible that some part of work efforts were performed by other teams, e.g., infrastructure and support teams from data center operations, and this is not observed as the data sample only included business applications.

Overall, it was expected that the development of higher resiliency, availability and backup solutions would increase spending on individual IT service technologies above the level considered standard in a case organization. However, it was not anticipated that the proportional increase in technology resources costs could be 30% to 65% more than the standard IT service in the case company. Extrapolating this effect to the IT application portfolio of a large organization would suggest a remarkable impact on cost performance and thus on the overall IS organizational success. This would explain the reason why the case company did require BCM only from prioritized IT services. Otherwise, overall costs would be significantly higher.

The results also show that internal activities are more costly than external ones, e.g., internal vs. external human and organizational resource costs. This was previously explained by the way the case company assigns BCM to the internal teams. A significant increase in costs can also be seen in those IT services that manage internally developed, proprietary and local-use applications. This supports the earlier view that customized and unique applications may require costlier BCM solutions. Interestingly, the cost impact on commercially configured applications, i.e., off-the-shelf systems, was negative with a ~-13% decrease. This could be explained by standardization, which can also include BCM solutions. Standardized IT solutions would use more shared resources and the maintenance could be done more cost effectively than customized systems that would require specific resources – both technology and human resources. The main learning from the results in Table 94 is that what was implicitly evaluated as BCM cost can be quantified so that it makes sense to the organization and could be used for general cost management discussions. After all, none of these observations were known to the case company.

7 Conclusions

The final chapter presents three theoretical contributions. The first and primary contribution is *the BCM activity cost model*, that is the final product for the main research question *how to determine the cost of BCM in IT services*. The second contribution is *the total cost of BCM framework*. This framework contributes the broader academic discussion of IS cost taxonomies in IT services and information security. The last contribution is the empirical confirmation to the theory how to observe unknown cost effects by multiple regression analysis. The learnings from this research can contribute IS researchers whose focus is on economic aspects of IS and IT. To aid IS research community, the goal was to offer transparent examination of the method and view on the results. This can enable replication of this research and support future applications in this research area.

In addition, this chapter introduces three practical contributions. The first one considers the observation of *the overall BCM cost effects on IT services*. Beside the overall effect, the results examine the costs between resource cost categories – human, technology and organizational resources. Although the results cannot be generalized based on this single case study to every company, this information may aid companies to evaluate BCM impact on their budgets. The second practical contribution considers the challenges regarding measurement of activity costs that can be difficult to observe directly. Within the limitations of this research, there are no reasons that the given *BCM activity cost model* could not be productized and integrated into other cost appraisal tools in a company or applied in other IT service management areas. The last important practical contribution is *the definitions of BCM activity cost variables*. Confirming the cost association between theoretical and empirical BCM frameworks can help BCM professionals to promote BCM process development in organizations. The final part of the chapter summarizes limitations of the research that needs to be considered when the results are reflected in another context. Lastly, future research suggestions are presented to encourage further research of the topic of BCM activity costs or even new applications of it.

7.1 Theoretical contributions

The primary contribution of this research is the original model of how to measure the cost of BCM activities in IT services – denoted as *the BCM activity cost model*. The main research question seeks an answer to how the costs of business continuity management activities can be determined for IT services. This question was motivated by the decision-making problems related to the methods for assessing indirect costs that arise in business continuity management. The model examines the effect caused by BCM activities on pre-incident costs of IT resources – generally termed as initial and continuous costs. Each activity type was derived from the IS literature and operationalized into independent variables for testing.

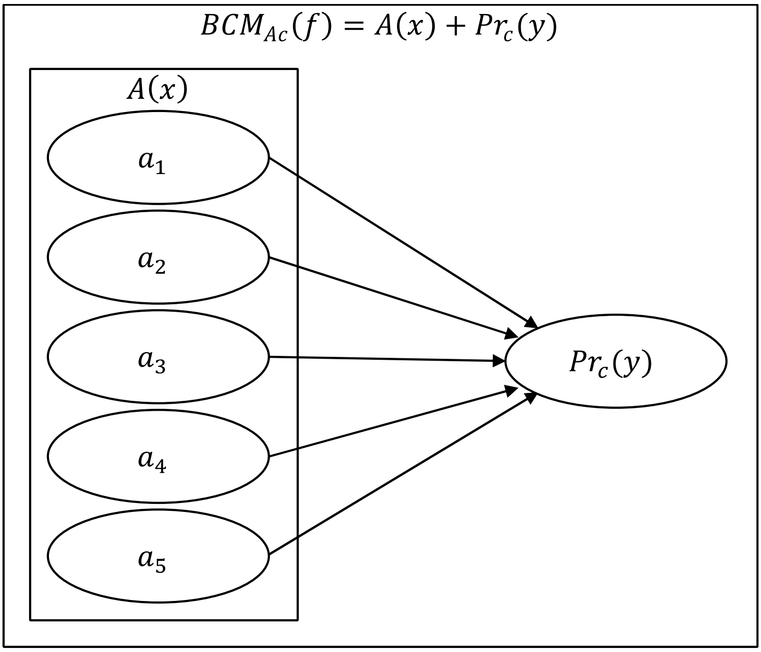

Figure 14. The BCM activity cost model.

In an ideal scenario, using the activity-based costing model (Cooper & Kaplan, 1992), the cost effect could be observed directly from financial reports. However, in this research, this was done indirectly using the statistical method. This was for practical reasons, as the case company did not have an activity-based costing model in place. Inspired by Benston (1966), a multiple regression analysis was used to test the cost effect of BCM activities. The BCM activity cost model was validated by testing multiple strata from the archived cost data of the case company using hierarchical multiple regression analysis. The fulfilment of all the assumptions of the multiple regression analysis allowed the further analysis. The empirical results supported both the statistical and practical significance of the research in the research context. The results suggests that BCM activities would explain average ~3.3% (min 0.8%, max 10.5%) of all reported costs, implying that the remaining 96.7% (min 99.2, max 89.5%) of effects could be explained by the other factors in the case company IT operations. The empirical result confirmed the effect through activity variables, but not every activity type correlated in practice. The absence of an activity in half of the test cases, namely the design activity, challenged the theoretical model which consisted of five activities. Despite this inconclusive observation, it was possible to quantify the proportional cost differences between the reference groups – the standard IT service, referred to as standard IT service, and the comparison group, the IT service with BCM, referred to as IT service with BCM, in percentages and by type of cost factors. All in all, the alternative explanation concerning the rejected null hypotheses suggested that each BCM activity explains a small but distinctive part of IT costs. As a conclusion, it can be argued that the cost of BCM can be determined by measuring the correlation between each BCM activity and IT service pre-incident costs as it was hypothesized.

The second theoretical contribution, *the total cost of BCM framework*, can be treated as essential but not the primary product of the research. The main research question emerged from the real-life management problem – how to justify the cost of BCM considering the unpredictable nature of disasters and crisis. Ultimately, it is a question of the trade-off between the opportunity cost and the cost of preparedness. To make this decision, one needs to know how BCM costs incur in IT in the longer term and in different situations. In the socio-technical context, as in IT services, there are several direct and indirect resource cost factors. In addition, costs can be organized by the point-in-time when they become material – such as initial and ongoing costs. Recognition of the BCM cost effect can be challenging due to diversity of cost taxonomies.

Table 95. The total cost of BCM framework.

	Pre-incident (Pr_c)		**Post-incident (Po_{cl})**	
	Initial (In_c)	Ongoing (On_c)	Intermediate (Im_{cl})	After (Af_{cl})
Indirect (Id_{cl})	Analysis work costs (c_1) design work costs (c_2) Implementation and development work costs (c_3)	Awareness and training work costs (c_6) Exercise, test, and maintenance work costs (c_7)	Incident management work costs (c_{10}) second party material losses (l_1)	Recovery, restoration, and financial claims work costs (c_{12}) Incident review and improvement work costs (c_{13}) Future revenue and value losses (l_3)
Direct (Di_{cl})	Hardware/ software purchases costs (c_4) Communication and infrastructure purchases costs (c_5)	Hardware/ software maintenance costs (c_8) Communication and Infrastructure maintenance costs (c_9)	Provisional software, hardware and utility resources purchases costs (c_{11}) First party material losses (l_2)	Hardware/ software purchases costs (c_{14}) communication and Infrastructure purchases costs (c_{15}) Productivity losses (l_4) Financial performance losses (l_5)

c = cost, *l* = loss

The grand idea how to resolve the challenge, was the total cost of the BCM framework (Table 95), which offers structure for this cost research. This was achieved primarily by synthesizing the cost factors of IT, information security and BCM from the IS literature. Most importantly it brings together different IS cost factors and the time perspective of cost materialization – from pre-incident state to the post-incident state. The binarily presented non-incident/ incident construction can be considered as a basic block of the lifecycle cost view. The framework can be seen as a continuum of paired pre-incident/ post-incident costs/loss events, where each post-incident state is followed by a new pre-incident state and so on. Though in this research empirical results contribute only the pre-incident cost perspective in the context of BCM in IT services, the framework is not limited to BCM only, but it can contribute IS and economics of information security cost research. According to Gordon & Loeb (2002) security spending should not be higher than the anticipated losses, which intrinsically requires understanding both cost and loss effects. In relation to this paradigm, the framework can help researchers to organize their observations while defining and testing associations between cost factors. Considering the antecedent researches, this framework can be seen as a synthesis of the security cost taxonomy by Anderson (2013), IT cost taxonomies by Irani et al., (2006) and the integrative framework of business continuity Niemimaa (2015) whose work was pivotal for the time based classification structure, proposed in this research.

The third, contribution, is empirical confirmation of using multiple regression analysis to observe unknown cost effects as suggested by Benston (1966). This contribution was the result of similar conditions as the previous one. Thus, this can be treated as equally essential but not the primary product of the research question. The initial assumption at the very beginning of the research was that the case company could provide cost data associated directly to BCM. But this was not the case. The management accounting model allocated costs of resources directly to the cost centers such as organizational units and IT services. Activity costs were not measured by the case company. Because of this, the cost of BCM could not be observed directly as planned. Inspired by Benston (1966), the research took a new course and successfully used multiple regression analysis to observe cost factors that were not directly observable.

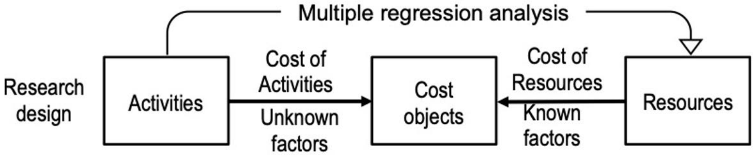

Figure 15. The observation unknown cost effects by multiple regression analysis.

As discussed in earlier chapters, properties of costs can be evaluated according to the principle of stochastic process by treating indirect measurements, e.g., operating costs, as statistical constructs. Benston (1966) suggested to measure non-observable recurring variables with multiple regression. The research presents the model where the cost of activities is measured statistically. Reflecting on the real IT cost trends confirms that the results were not arbitrary but probably reflect the reality in the case company.

The analysis process was not straightforward but required fulfilment of several conditions and clarity of how the results can be interpreted. Fundamentally, it was all about how to accept and to interpret multiple regression results when the dependent variable is continuous and independent variables are dichotomous aka. dummy variables. The research provides details of assumptions of multiple regression analysis to test first if the method can be used in context of a research. The fulfilment of all requirements validates that the idea of measuring the correlation between quantitative cost and categorical activity type data can be done when categorical classes are converted into distinctive dichotomous variables. Consequently, this has inherent causal-comparative characteristic. As it can be seen from the research, the method produces information about the differences between reference and comparison groups – in this research, the cost difference between IT service without and with BCM activities.

This observation can increase the knowledge of methodological approaches in IS research that are focused on economic aspects. One such issue may be how to remove the barriers to quantifying the cost of security. This stems from the realization that, at a conceptual level, BCM activities can be replaced by other types of activities and IT costs by other cost types. The statistical testing model does not make any difference from which discipline the variables originate, as long as the paradigm of activity-based costing and the assumptions of multiple regression analysis have been followed. The economics of information security research, which looks at security spending and cost-benefit, may benefit from adopting the research methodology to attain knowledge about security or privacy activities. Such research could identify e.g. how regularly performed privacy activities correlate with cost of operations. The validation of the cost appraisal method, which facilitates the analysis of unknown cost factors by integrating activity-based costing theory with multiple regression analysis, can contribute to research even beyond IS.

7.2 Practical contributions

As discussed in the introduction, IT costs can be a substantial part of cost of operations affecting the company's financial performance therefore IT leaders are balancing between cost and information systems performance and availability decisions. Thus it is not surprising that business continuity management is amid the most important concerns of IT leaders (Kappelman, 2020). The value of BCM may not be observed until something exceptional happens – a disruption at so large that what is considered within range of normal response is not enough. As such events are uncommon, convincing senior management to spend on BCM on a level anticipated by the IT management can be challenging. This research provides two practical contributions to these discussions. First, it provides insight to *the overall BCM cost effects on IT services*. Figure 16 shows the share of costs between different people and technologies. Most importantly it allows benchmarking between the case company BCM activity costs with other companies and cost types. According to the research, BCM activities caused average ~3.5% cost effect in the case company IT budgets. This seems to be roughly half of the cybersecurity costs in the surveyed companies. As the research relates to a single case company and the results are based on past cost trends, extrapolating the findings into the current IT service environments, which nowadays are increasingly dominated by cloud services, must be done with caution. Nevertheless, the empirical results do raise the question of how activities, such as BCM, consume resources. This information can help IT leaders to communicate expected cost effects when pursuing to improve IT services continuity capability.

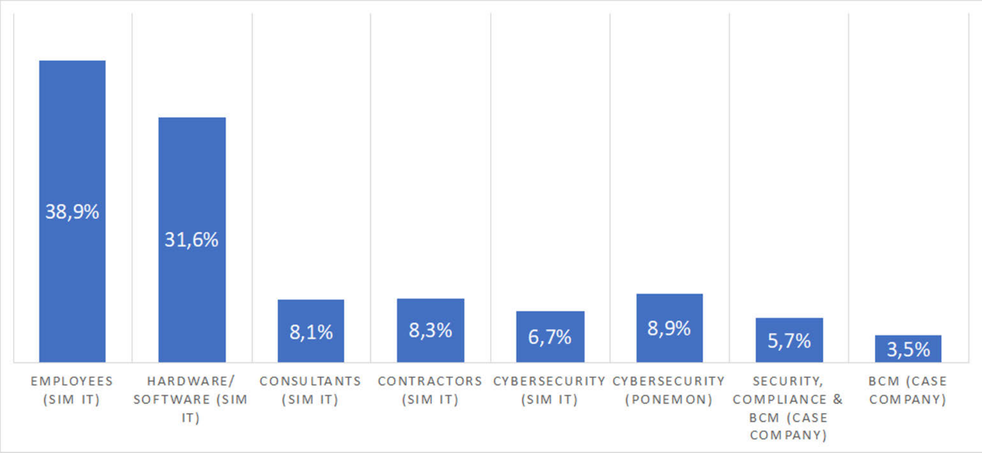

Figure 16. Average % of IT budget allocations 2005–2020 (summary from figure 13).

The empirical results of longitudinal BCM activity cost effects can offer a reference point, but for a company understanding the cost effect in one own context can be equally important. Development of cost analysis methods can improve transparency of the costs, thus improve overall IT budget management. As it has been observed, BCM activity cost model produces results that do not differ from other management areas in an organization. As a practical contribution *the BCM activity cost model* can help IT management to identify cost factors and to plan how to control costs to optimal range. This may increase the senior management's confidence to invest in BCM as impact on company operational expenses becomes foreseeable. The research results can certainly guide the discussion in business IT on how to measure costs that are not inherently accounted for in an organization. Considering the way the research was conducted, it may require a relatively small amount of effort to translate this research into a business planning application. In practice, a company can adapt the research model by establishing an activity tracking practice and merging this data with the company's cost data. By comparing the proportion of the IT budget and the effect size of the BCM activity, the BCM cost estimate can be extrapolated to the IT services. Further, the approach can be extended to ITIL processes, maturity models and any well-defined and measured business process. As an example, it would be an interesting use case to measure the total cost of information security by modifying the BCM activity cost model into security activities.

Furthermore, the research can help business continuity practitioners to develop BCM processes as it offers validation of *the BCM activity cost variables*. This empirical evidence of the ostensive aspects of BCM activities as a real-life phenomenon can contribute to the discussion of the structural components of BCM frameworks as well as how to improve the organizational preparedness by methods and processes in IS. Practical use case can be an implementation of ISO 22301:2019 business continuity management system (International Organization for Standardization, 2019). As the research results shows, at least four activities did have observable cost effect. The one variable, namely BCM design activity, could not be either supported on rejected. Despite this, the observation supports the idea that when a company explicitly defines activities and associated tasks, it can set unambiguous goals to the e.g. IT service teams. As the case company shows, teams can be rewarded as they achieve the goals – in this case completions of the tasks for each BCM activity. Adopting ISO requirements into the BCM activities may ensure the implementation of ISO certified BCM system on cost-controlled manner.

7.3 Limitations and future research suggestions

There are obvious limitations in the research that need to be considered both in academic discussion and in possible practical utilization. While the case study approach provides a fit-for-purpose methodological framework to conduct this research, there are some limitations considering research findings. Generalizability of research is the extension of research findings from a study conducted on one sample population to the entire population – therefore, larger or multiple sample populations allow for generalization of findings to a broader range of the population (Lee & Baskerville, 2003). In order to have representative random samples research, theoretically, we would need to have access to all organization types and then, by using random sampling methods, select representative samples of suitable organizations for our research. Since the result is based on a single case organization, an alternative perspective on statistical generalizability is needed. An alternative way to attain generalizable results, a researcher may base arguments on one of the four strategies suggested by Lee and Baskerville (2003). While the classification seems to be a convenient tool for a researcher, it may have issues as remarked by Tsang & Williams (2012). Considering all above, it is acknowledged that testing the cost of BCM hypothesis on a single organization, limits the generalizability of the results to other environments and leaves room for other researchers to confirm whether or not the proposed model works. Therefore, this research can consider generalization from empirical statements to the theoretical statements on BCM activity costing in information system and security economics.

However, there is another viewpoint in the research to be considered – the research approach itself. While the way how BCM activities are designed and implemented may differ between organizations, it can be assumed that the model how BCM activity costs are determined in this research, could be generalized to a different population at another point in time. This would require that the same conditions that applied to the case organization, applies also to the population or the another case company (Tsang & Williams, 2012). Generalizing the findings from the single case company to other companies requires careful consideration due to the differences in the way companies operate, even within the same industry. Even if companies compete in the same markets, the way human, technological and organizational resources are consumed can differ greatly depending on the strategy. Because of these organizational differences, BCM approaches may vary between companies thus BCM activities are likely embedded other companies differently as in the case company's IT department. Despite this, it can be argued that even though the empirical findings from the case company are very much situational, the results can be generalized to IT service continuity management cost discussion as a baseline model that can be corrected over time when new data is available.

The empirical results are based on a comprehensive and long-term data set for both the dependent and independent variables, and although the results are cross-validated by using multiple purposefully selected strata, there are limitations to the extent to which the results can be interpreted. To ensure comparable and consistent results, it was decided to limit use cost data from business applications only. For this reason, the results cannot be directly generalized to the costs of IT infrastructure and support service in the case company – for example create cost types were not included as they were associated to company-wide programs. The archival data used in the research was from 2006 to 2012. Since that time, the case organization has overcome organizational and technological changes. It can be assumed that the BCM activity costs have changed since then, e.g., through the use of cloud technologies.

The quantitative research approach had methodological limitations. Although extensive and diverse archival data was available for the research, including IT continuity plans, BCM process and IT management documentation as well as service level documentations, the research process did not include qualitative discussions with representatives of the case company for reasons of practical availability. Therefore, all the results are limited to documentations and the archive data only. Additional interviews could have enriched the overall discussion of the results. Multiple regression analysis is a popular method as it is both robust and versatile for different research contexts. The reliability and validity of the method depended largely on the researcher's choice of data used in testing and how the variables have been operationalized. As this research is the result of a single researcher, there is a residual risk that a systemic error has been introduced into the testing model at some point in the process. These may have been the result of bias or inexperience in methodological skills.

What new can be learned from the archival data used in this research as it may not reflect present day costs? This very relevant question can be answered by the following perspectives. The goal was to determine the BCM activity cost model with actual data. Current data is by default historical data and may have been collected a decade ago, but this does not affect the validity of the model if all data are from the same time and sources. The sole purpose was to test with real data if the hypothesized BCM activity cost model could measure real life phenomenon, which it did, based on the results.

As we can observe in BCM literature and reflecting modern IT continuity standards, BCM and IT continuity management processes have the same activity components. If we look at the latest SIM IT survey, we can see that IT cost taxonomies are interchangeable with the proposed resource cost types, human, technology and organizational costs. In practice, this means that the research offers a resource that can be tested by scholars researching cost aspects of BCM, economics of security and IT costs. It would particularly be interesting to learn how to develop the total cost BCM framework from one-way linear representation into the cyclic form to express the dynamic and volatile nature of IS costs.

Considering future research, the results could be generalized temporally to a different population at another point in time, provided that the same conditions that applied to the case organization also apply to the population. Validating the results in another company would increase the knowledge of whether the cost of BCM can be determined with the proposed BCM activity cost model. It would be particularly interesting to re-run the analysis again in a case company to see what has changed and whether the BCM activity cost model still works in a given context. There seems to be a correlation between IT service designs and the cost of BCM activities, as we can observe a change in costs due to IT service designs. As discussed, earlier IT service design can be seen as a precursor to BCM, as it set the expectations and possible limitations on how BCM can be integrated into the IT service. Exploring the moderator effect of IT service design on BCM activities could be an interesting topic. In this research, control variables were used to better observe the change in impact of BCM activities. The results suggested that both the security and compliance control variables had an observable effect on IT service costs. These results strongly suggest adjusting the BCM activity cost model to examine the costs of security and compliance activities at a more detailed level. In addition to validating the above variables, it would be extremely interesting to see how the proposed method would work with other activity types in IS or even in another context, in order to increase knowledge about the cost of activities beyond BCM.

Abbreviations

APP	Application
BCM	Business Continuity Management
DRP	Disaster Recovery Plan
BCP	Business Continuity Plan
BC	Business Continuity
ABC	Activity Based Costing
CAD/CAE	Computer Aided Design/ Computer Aided Engineering
CV	Control Variable
DV	Dependent Variable
DS	Data Security Classification
HW	Hardware
HWM	Hardware Management
IV	Independent Variable
ISCM	Information Systems Continuity Management
ITIL	The Information Technology Infrastructure Library
LEV	Leverage values
MM	Maturity Models
MLR	Multiple Linear Regression
SS	System Security Classification
SV	Selection Variable
SLA	Service Level Agreement
SLO	Service Level Objectives
SOX	Sarbanes – Oxley Act
SW	Software
SWM	Software Management
SLM	Service Level Management
ITSM	Information Technology Service Management
UID	Unique Identifier
VIF	Variance Inflation Factor
WE	Work Effort number

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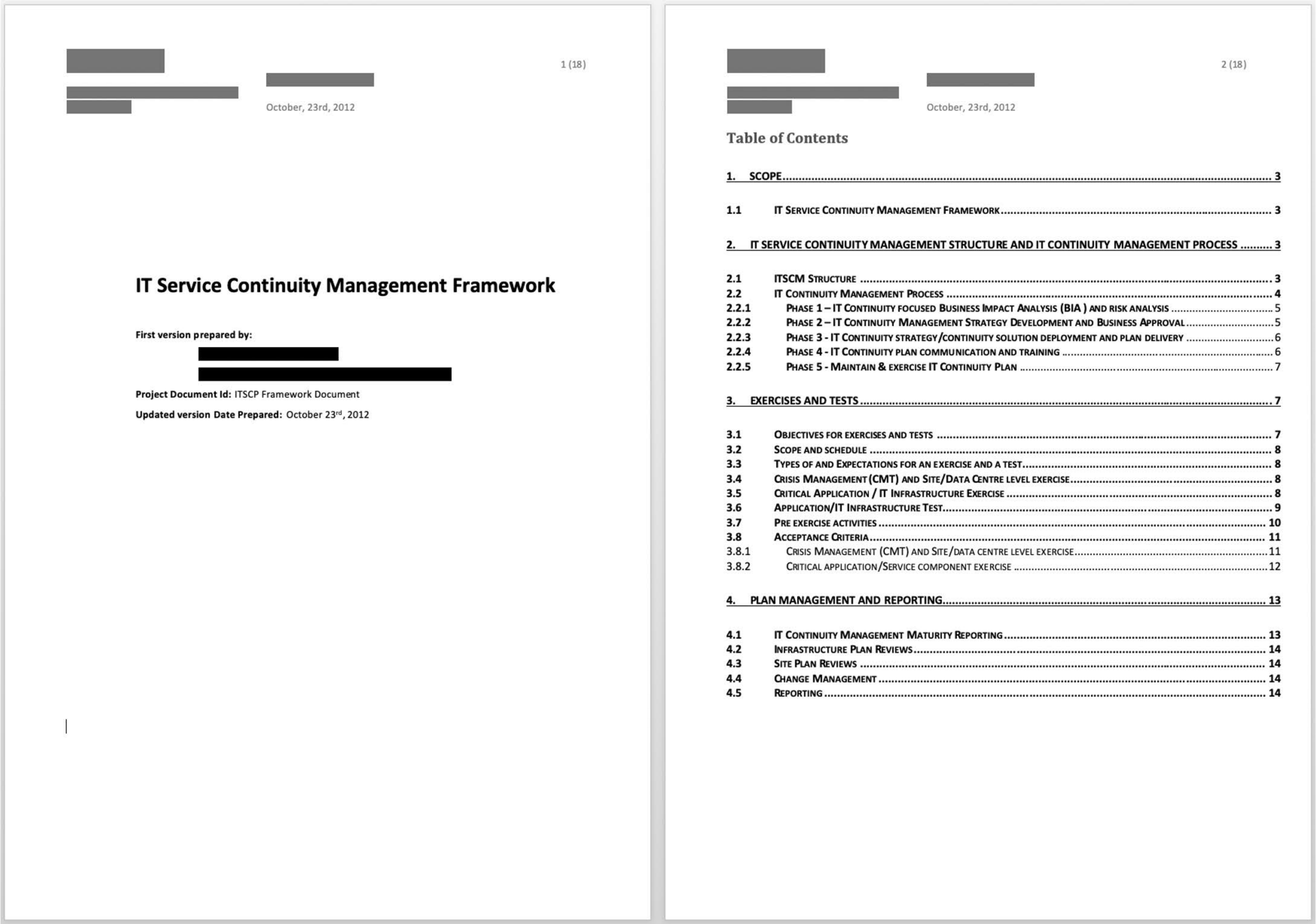
Appendices

Appendix 1. IT service continuity management framework.



[redacted]

[redacted]

1 (18)

October, 23rd, 2012

IT Service Continuity Management Framework

First version prepared by:

[redacted]

Project Document Id: ITSCP Framework Document

Updated version Date Prepared: October 23rd, 2012

[redacted]

[redacted]

2 (18)

October, 23rd, 2012

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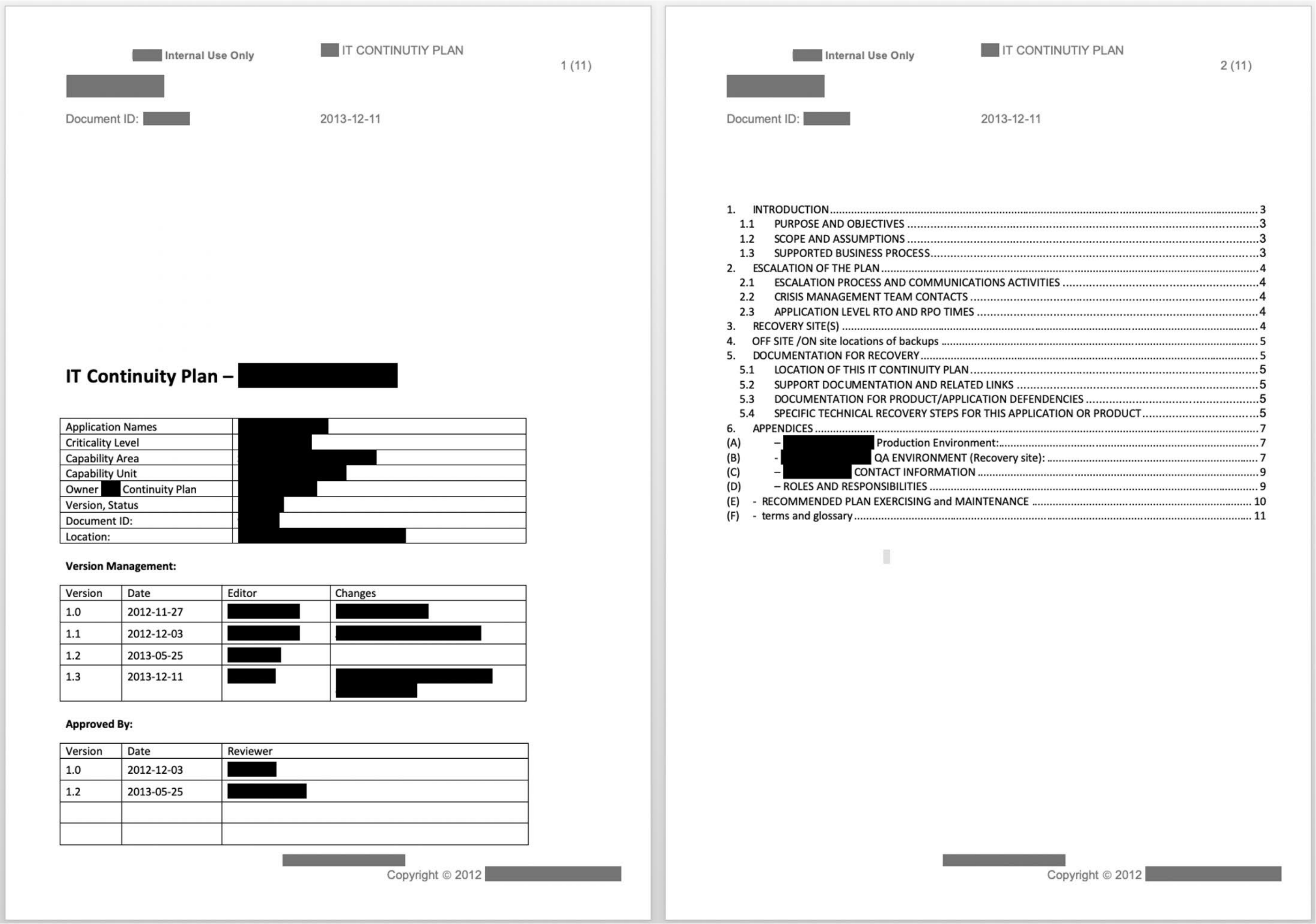
Appendix 2. IT service continuity plan sample.



[redacted] Internal Use Only

[redacted] IT CONTINUTIY PLAN

1 (11)

[redacted]

Document ID: [redacted]

2013-12-11

IT Continuity Plan – [redacted]

Application Names	[redacted]
Criticality Level	[redacted]
Capability Area	[redacted]
Capability Unit	[redacted]
Owner [redacted] Continuity Plan	[redacted]
Version, Status	[redacted]
Document ID:	[redacted]
Location:	[redacted]

Version Management:

Version	Date	Editor	Changes
1.0	2012-11-27	[redacted]	[redacted]
1.1	2012-12-03	[redacted]	[redacted]
1.2	2013-05-25	[redacted]	
1.3	2013-12-11	[redacted]	[redacted]

Approved By:

Version	Date	Reviewer
1.0	2012-12-03	[redacted]
1.2	2013-05-25	[redacted]

[redacted]

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[redacted] Internal Use Only

[redacted] IT CONTINUTIY PLAN

2 (11)

[redacted]

Document ID: [redacted]

2013-12-11

[redacted]

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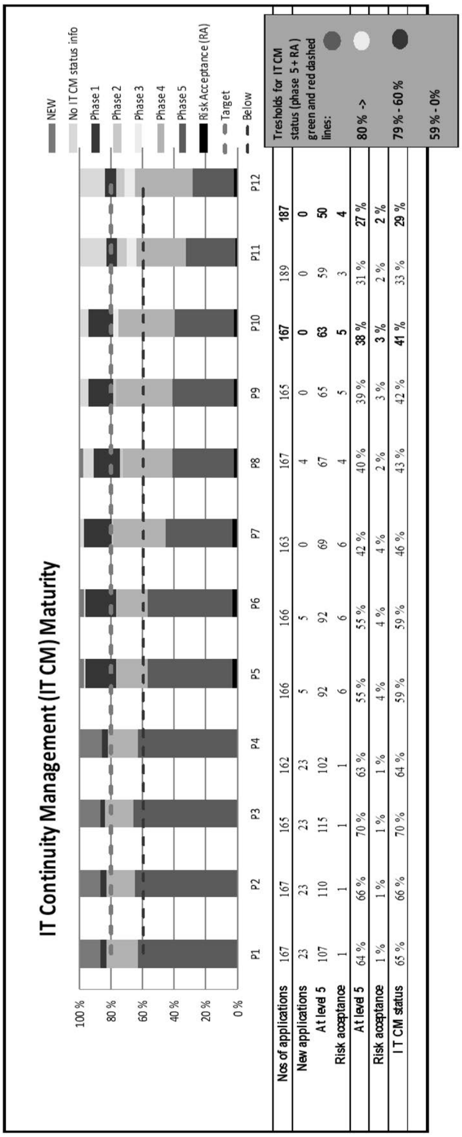
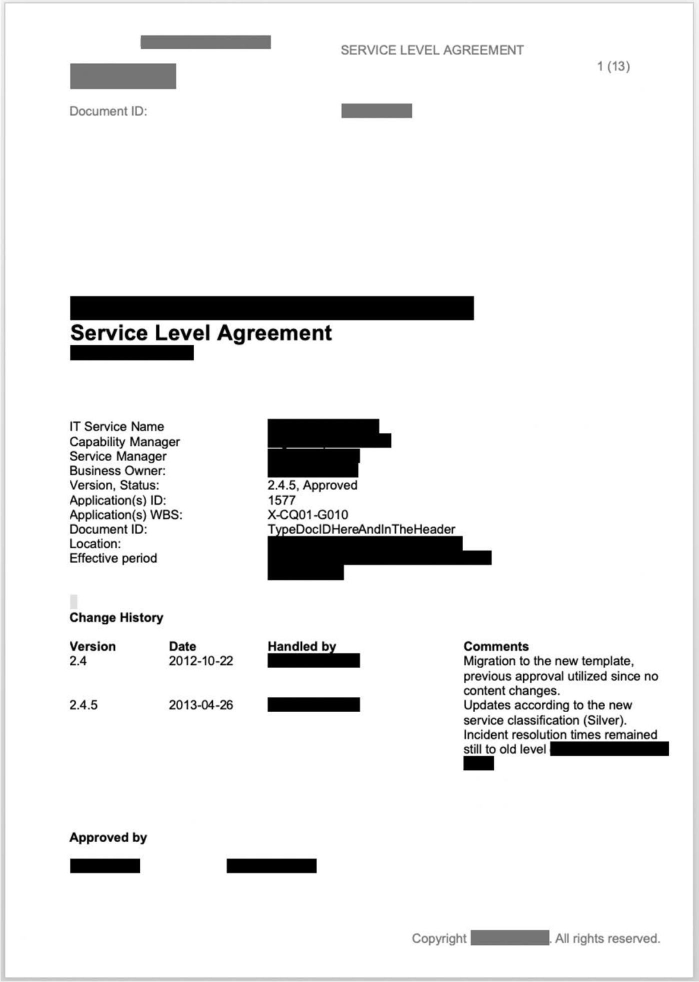
Appendix 3. IT service BCM status extract sample.



	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Nos of applications	167	167	165	162	166	166	163	167	165	**167**	189	**187**
New applications	23	23	23	23	5	5	0	4	0	**0**	0	**0**
At level 5	107	110	115	102	92	92	69	67	65	**63**	59	**50**
Risk acceptance	1	1	1	1	6	6	6	4	5	**5**	3	**4**
At level 5	64 %	66 %	70 %	63 %	55 %	55 %	42 %	40 %	39 %	**38 %**	31 %	**27 %**
Risk acceptance	1 %	1 %	1 %	1 %	4 %	4 %	4 %	2 %	3 %	**3 %**	2 %	**2 %**
I T CM status	65 %	66 %	70 %	64 %	59 %	59 %	46 %	43 %	42 %	**41 %**	33 %	**29 %**

The case company BCM scorecard the shows the progress of BCM in IT services on each month. Phases 1–5 are BCM activities. IT department set the time goal for reaching specific phase. In this report the target is to have 80% of application on phase 5 state (tested and managed). Risk acceptance means approval for not meeting phase 5. Possible reasons could be system ramp down or change procedures.

Appendix 4. IT service level agreement sample.



[redacted] [redacted] SERVICE LEVEL AGREEMENT 1 (13)

Document ID: [redacted]

[redacted]

Service Level Agreement

[redacted]

IT Service Name	[redacted]
Capability Manager	[redacted]
Service Manager	[redacted]
Business Owner:	[redacted]
Version, Status:	2.4.5, Approved
Application(s) ID:	1577
Application(s) WBS:	X-CQ01-G010
Document ID:	TypeDocIDHereAndInTheHeader
Location:	[redacted]
Effective period	[redacted]

Change History

Version	Date	Handled by	Comments
2.4	2012-10-22	[redacted]	Migration to the new template, previous approval utilized since no content changes.
2.4.5	2013-04-26	[redacted]	Updates according to the new service classification (Silver). Incident resolution times remained still to old level [redacted]

Approved by

[redacted] [redacted]

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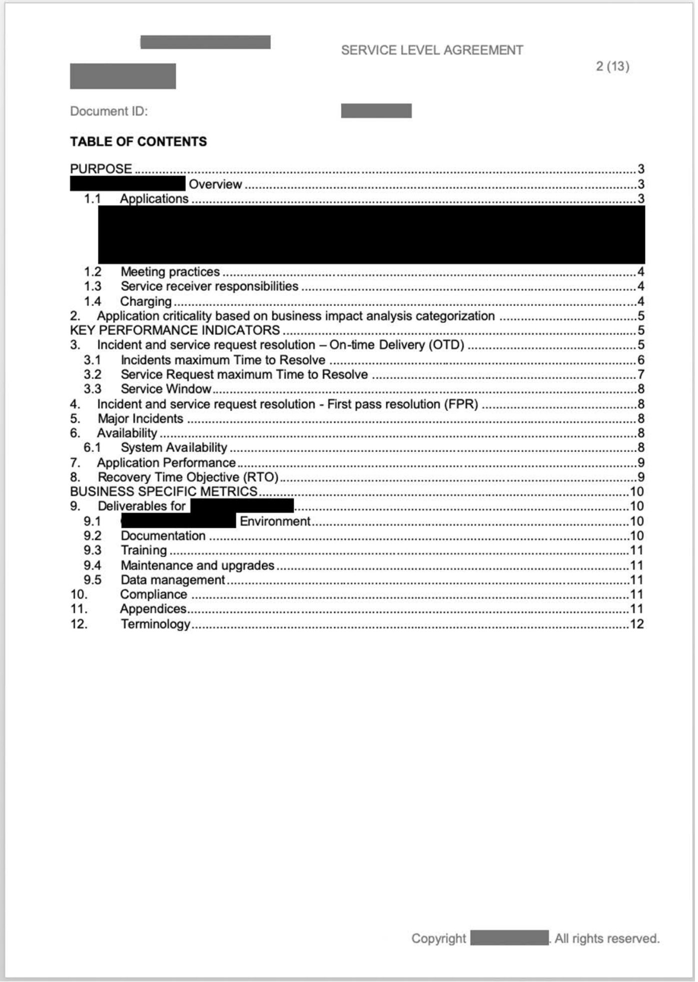

[redacted] [redacted] SERVICE LEVEL AGREEMENT 2 (13)

Document ID: [redacted]

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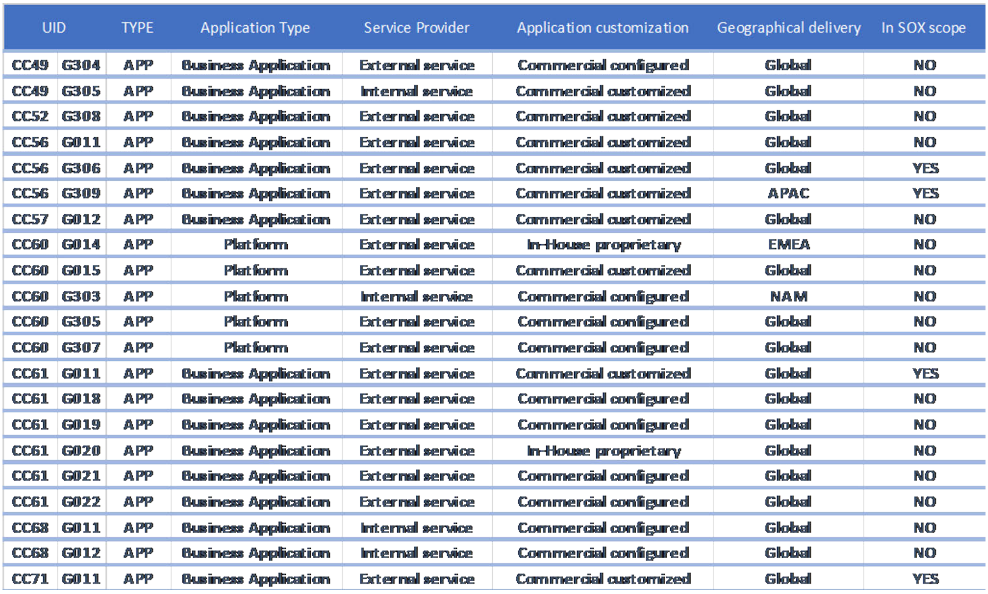
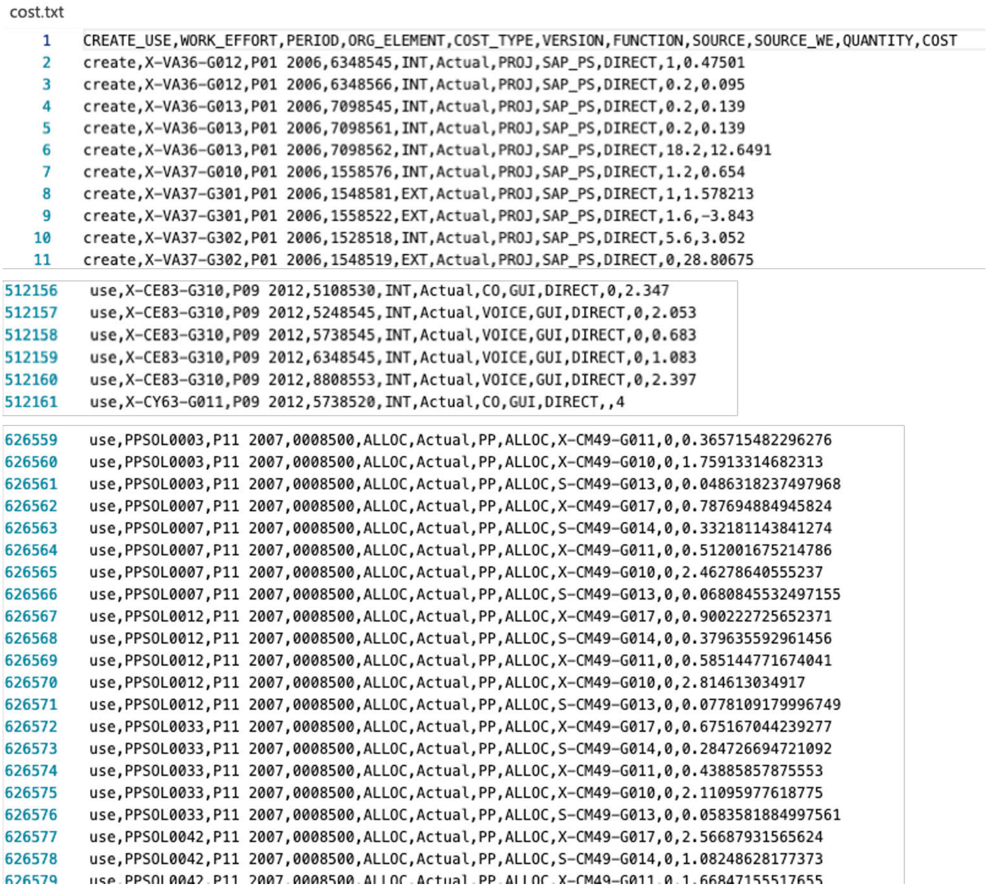
Appendix 5. IT services objectives database extract sample.



UID		TYPE	Application Type	Service Provider	Application customization	Geographical delivery	In SOX scope
CC49	G304	APP	Business Application	External service	Commercial configured	Global	NO
CC49	G305	APP	Business Application	Internal service	Commercial customized	Global	NO
CC52	G308	APP	Business Application	External service	Commercial customized	Global	NO
CC56	G011	APP	Business Application	External service	Commercial customized	Global	NO
CC56	G306	APP	Business Application	External service	Commercial customized	Global	YES
CC56	G309	APP	Business Application	External service	Commercial customized	APAC	YES
CC57	G012	APP	Business Application	External service	Commercial customized	Global	NO
CC60	G014	APP	Platform	External service	In-House proprietary	EMEA	NO
CC60	G015	APP	Platform	External service	Commercial customized	Global	NO
CC60	G303	APP	Platform	Internal service	Commercial configured	NAM	NO
CC60	G305	APP	Platform	External service	Commercial configured	Global	NO
CC60	G307	APP	Platform	External service	Commercial configured	Global	NO
CC61	G011	APP	Business Application	External service	Commercial customized	Global	YES
CC61	G018	APP	Business Application	External service	Commercial configured	Global	NO
CC61	G019	APP	Business Application	External service	Commercial configured	Global	NO
CC61	G020	APP	Business Application	External service	In-House proprietary	Global	NO
CC61	G021	APP	Business Application	External service	Commercial configured	Global	NO
CC61	G022	APP	Business Application	External service	Commercial configured	Global	NO
CC68	G011	APP	Business Application	Internal service	Commercial configured	Global	NO
CC68	G012	APP	Business Application	Internal service	Commercial configured	Global	NO
CC71	G011	APP	Business Application	External service	Commercial customized	Global	YES

Appendix 6. IT cost data extract sample.



cost.txt

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create,X-VA36-G012,P01 2006,6348566,INT,Actual,PROJ,SAP_PS,DIRECT,0.2,0.095
create,X-VA36-G013,P01 2006,7098545,INT,Actual,PROJ,SAP_PS,DIRECT,0.2,0.139
create,X-VA36-G013,P01 2006,7098561,INT,Actual,PROJ,SAP_PS,DIRECT,0.2,0.139
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create,X-VA37-G010,P01 2006,1558576,INT,Actual,PROJ,SAP_PS,DIRECT,1.2,0.654
create,X-VA37-G301,P01 2006,1548581,EXT,Actual,PROJ,SAP_PS,DIRECT,1,1.578213
create,X-VA37-G301,P01 2006,1558522,EXT,Actual,PROJ,SAP_PS,DIRECT,1.6,-3.843
create,X-VA37-G302,P01 2006,1528518,INT,Actual,PROJ,SAP_PS,DIRECT,5.6,3.052
create,X-VA37-G302,P01 2006,1548519,EXT,Actual,PROJ,SAP_PS,DIRECT,0,28.80675
```

```
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use,X-CE83-G310,P09 2012,5738545,INT,Actual,VOICE,GUI,DIRECT,0,0.683
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use,X-CE83-G310,P09 2012,8808553,INT,Actual,VOICE,GUI,DIRECT,0,2.397
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```

```
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Appendix 7. BCM Pattern matching cross-reference Table.

Theoretical BCM activity model		**Empirical BCM model**	
Activities	Tasks (Table 1)	Observed Yes (Y) No (N)	Notes
Establish the program	Top management support	Y	BCM objectives linked to IT service teams' incentives
	Objective setting	Y	BCM objectives linked to IT service teams' incentives
	Program initiation	N	No specific program, but management system
	Project initiation	N	No BCM project, but management system
	Project planning	N	No BCM project, but management system
	Project proposal	N	No BCM project, but management system
	Project management	N	No BCM project, but management system
	Form framework and policies	Y	IT service continuity management framework document
	Organize the planning team	Y	3 BCM specialists and a manager for IT continuity management. IT service teams responsible of BCM implementation
	Deploy governance	Y	Part of IT management system
	Deploy scope	Y	IT services and data centre operations
	Deploy investment	N	No specific investment. BCM treated as a part of IT running costs. IT continuity solutions part of IT service budget planning
Understand the organization	Process analysis	Y	Dependency mapping
	Resource analysis	Y	Dependency mapping
	Event analysis	N	No in the scope of BCM but in IT outsourcing processes
	Risk assessment	Y	
	Business impact analysis	Y	Restore order for critical processes and applications (incl. infrastructure) Recovery Time Objective (RTO) Recovery Point Objective (RPO) Critical timelines and dates
	Business continuity plan requirements	Y	IT service continuity template
	Environmental and system analysis	Y	Description of logical architecture and physical architecture

Theoretical BCM activity model		**Empirical BCM model**	
Determine the business continuity strategy	Prioritize activities	Y	Based no BIA results
	Define risk reduction/ mitigation strategies	Y	Basic strategies pre-defined to be applied case based
	Determine business continuity strategies	Y	Strategy include cost-benefit analysis and management approval
	Design business continuity plan	N	Standard template for all IT services
	Define recovery resource requirements	Y	Part of strategy planning
	Define policies and procedures	Y	Processes defined in IT continuity plans
Develop and implement the plan	Implement the strategy	Y	
	Develop the business continuity plan and the disaster recovery plan	Y	IT service continuity template
	Plan for customer management	Y	Internal customer communication in IT continuity plans
	Relocation plan for people transport	Y	IT continuity plan section
	Develop business continuity centres	Y	Alternate site for services and teams determined in IT continuity plan
	Create maintenance plans	Y	Guidelines in the BCM framework
	Incident response plans	Y	IT continuity plan section
	Implement IT redundancies	Y	Solutions described in IT continuity plans
	link plans with change management	Y	Guidelines in the BCM framework to test plans after any service changes
	Monitor and control plan implementation	Y	IT continuity maturity model and reporting guidelines

Theoretical BCM activity model		Empirical BCM model	
Embedded business continuity into organization	Business continuity plan training	Y	Provided by BCM team in IT
	Education	N	
	Awareness	Y	Provided by BCM team in IT
Exercise, test and maintain the plan.	Regular testing	Y	Guidelines in the BCM framework
	Simulation and plan exercises	Y	Guidelines in the BCM framework
	Maintain and update the plan	Y	Guidelines in the BCM framework
	Review plans and processes	Y	BCM team in IT

Appendix 8. IT service management pattern matching cross-reference Table.

Theoretical IT service management model		Empirical IT service management model	
Level	IT service management activities (Table 2)	Observed Yes (Y) No (N)	Notes
Operational level	Configuration management	Y	IT service level agreements
	Change management	Y	IT service level agreements
	Release management	Y	IT service level agreements
	Incident management	Y	IT service level agreements
	Problem management	Y	IT service level agreements
	Service-desk	Y	IT service level agreements
Tactical level	Service level management	Y	IT service level agreements
	Availability management	Y	IT service level agreements
	Capacity management	Y	IT service level agreements
	Financial management	Y	Service Cost reporting
	IT service continuity	Y	IT service level agreements

Appendix 9. IT cost pattern matching cross-reference Table.

Theoretical IT cost model	**Empirical IT cost model**	
Cost type (Table 4)	Observed Yes (Y) No (N)	Notes
Initial (one-off) costs	Y	Included in: direct assigned costs
Policies & plans costs	N	
Hardware purchases costs	Y	HW cost type
Software purchases cost	Y	SW cost type
Customization costs	N	Included in: SW and HW types
Installation costs	N	Included in: SW and HW types
Consulting costs	N	Included in: EXT cost type
Infrastructure costs	Y	Allocation cost types
Ongoing costs	Y	Included in: direct assigned cost type
Hardware maintenance costs	Y	HWM cost type
Software maintenance costs	Y	SWM cost type
Support costs	N	Included in: SWM and HWM cost types
Change costs	N	Included in: SWM and HWM cost types
Lease costs	N	Included in: SWM and HWM cost types
Keeping the Lights On costs	N	Included in: SWM and HWM cost types
Testing costs	N	Included in: SWM and HWM cost types
Auditing cost	N	Included in: SWM and HWM cost types
Insurance costs	N	Included in: SWM and HWM cost types
Decommissioning costs	N	Included in: SWM and HWM cost types
Personnel costs	Y	INT, EXT work costs
Cost for training	N	
Cost of management and staff dealing with procurement	N	
Cost of management and staff required to start-up activities	N	
Cost of management administration and operation activities	N	
Cost of application development	N	
Project management costs	N	
Changes in salaries	N	
Organizational costs (social sub-system)	N	
Costs of business process restructuring	N	
Costs for change management	N	
Disruption/ productivity costs	N	
IT capital investment costs	N	
Outsourcing costs	Y	OUTsourcing, SUBcontractor, EXTernal work cost
BI/analytics costs	N	
IT-Related R&D costs	N	
Offshore IT costs	Y	OUTsourcing and EXT cost
ITIL Processes	N	
Security (defence) costs	N	

Appendix 10. Independent variable (IV) dummy coding.

Id	IV coding	X_0	X_1	X_2	X_3	X_4	X_5
IV0	No_BCM due to standard IT service status – valid only IF no BCM activity associated. Operates as a reference value/ constant in analysis	0	0	0	0	0	0
IV1	BCM_analyzing_activity – IF reported 1. then = 1 else = 0	0	1	0	0	0	0
IV2	BCM_designing_activity – IF reported 2. then = 1 else = 0	0	0	1	0	0	0
IV3	BCM_ implementing _activity – IF reported 3. then = 1 else = 0	0	0	0	1	0	0
IV4	BCM_ embedding _activity – IF reported 4, then = 1 else = 0	0	0	0	0	1	0
IV5	BCM_ maintenance _activity – IF reported 5, then = 1 else = 0	0	0	0	0	0	1

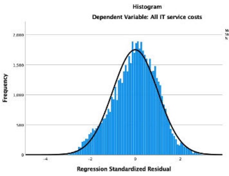
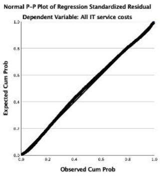
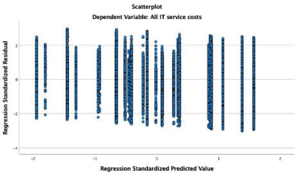
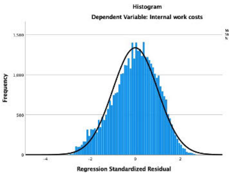
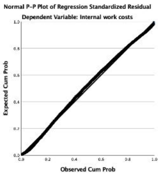
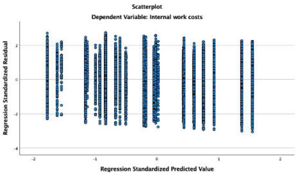
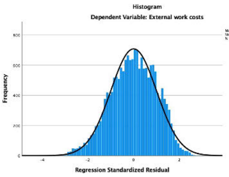
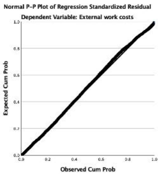
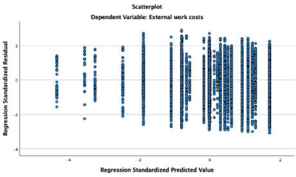
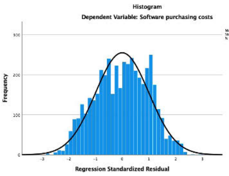
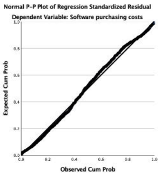
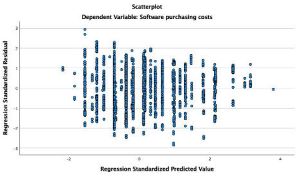
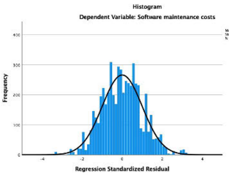
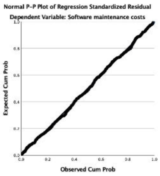
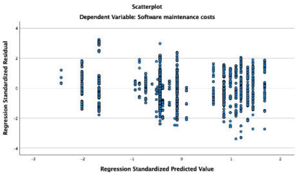
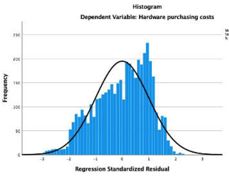
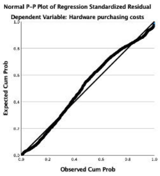
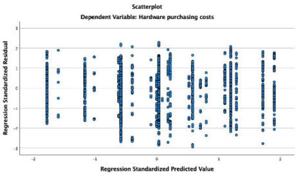
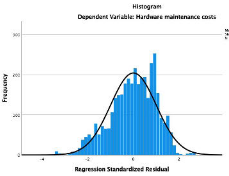
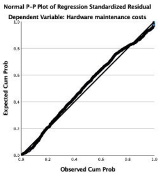
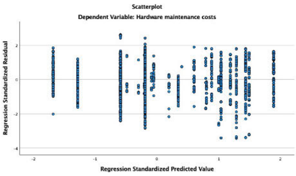
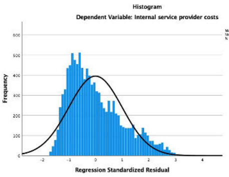
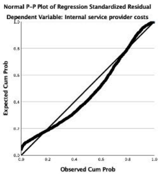
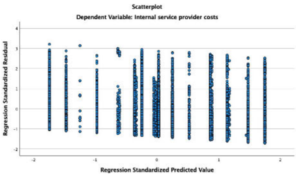
Appendix 11. Control variable (CV) coding.

Id	CV coding	X_6	X_7
CV1	SLA _security_class – IF SLO attribute, then = 1 else = 0	1	0
CV2	SLA_compliance_class – IF SLO attribute, then = 1 else = 0	0	1

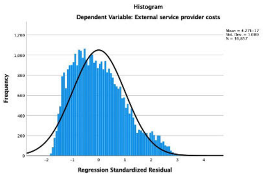
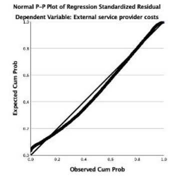
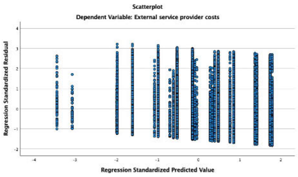
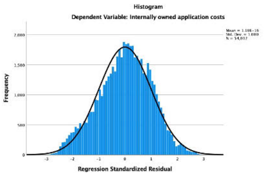
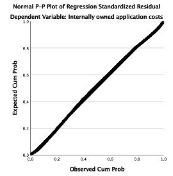
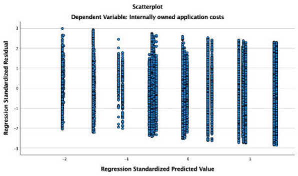
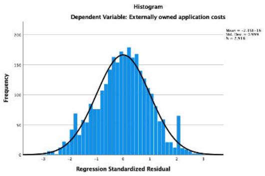
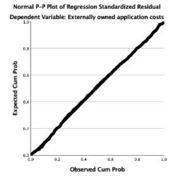
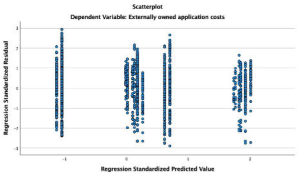
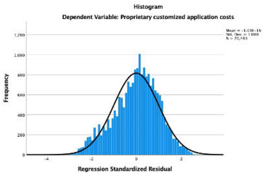
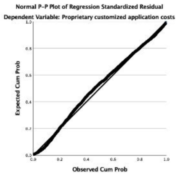
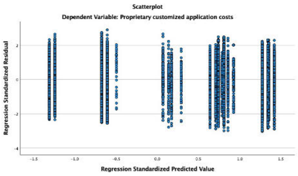
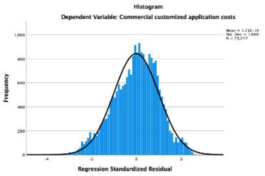
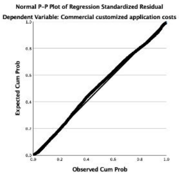
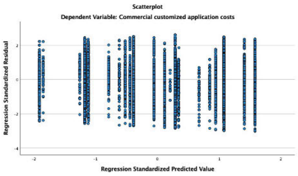
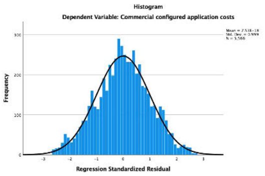
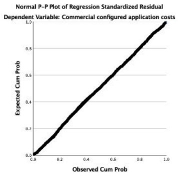
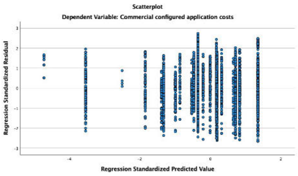
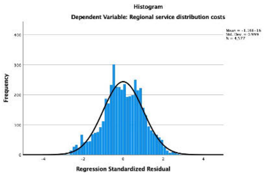
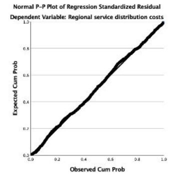
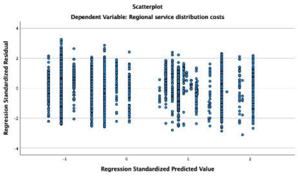
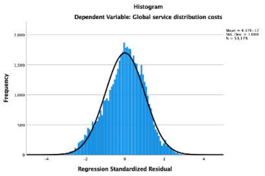
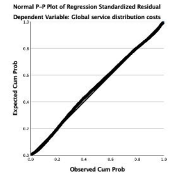
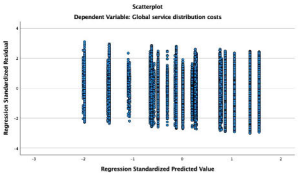
Appendix 12. Cost strata selection variable (SV) coding.

SV coding
SV_accounting_cost_type = INT, then = select, else = reject
SV_accounting_cost_type = EXT, then = select, else = reject
SV_accounting_cost_type = SUB, then = select, else = reject
SV_accounting_cost_type = OUT, then = select, else = reject
SV_accounting_cost_type = INT, then = select, else = reject
SV_accounting_cost_type = SW, then = select, else = reject
SV_accounting_cost_type = SWM, then = select, else = reject
SV_accounting_cost_type = HW, then = select, else = reject
SV_accounting_cost_type = HWM, then = select, else = reject
SV_service_provider_cost_type = internal, then = select, else = reject
SV_service_provider_cost_type, external = select, else = reject
SV_system_ownership_cost_type = internal, then = select, else = reject
SV_system_ownership_cost_type = external, then = select, else = reject
SV_system_customization_cost_type = Proprietary customised, then = select, else = reject
SV_system_customization_cost_type = commercial customised, then = select, else = reject
SV_system_customization_cost_type = commercial configured, then = select, else = reject
SV_service_distribution_cost_type = regional, then = select, else = reject
SV_service_distribution_cost_type = global, then = select, else = reject

Appendix 13. Strata 1–8: scatter-, normal distribution and normal P-P plots.

Strata	Normal distribution	Normal P-P plot	Scatterplot
1			
2			
3			
4			
5			
6			
7			
8			

Appendix 14. Strata 9–16: scatter-, normal distribution and normal P-P plots.

Strata	Normal distribution	Normal P-P plot	Scatterplot
9			
10			
11			
12			
13			
14			
15			
16			

Appendix 15. Tolerance and VIF.

	Stratum 1		**Stratum 2**		**Stratum 3**		**Stratum 4**	
Model 1	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
CV1	1.000	1.000	1.000	1.000	1.000	1.000		
Model 2							1.000	1.000
CV1	1.000	1.000	1.000	1.000	0.999	1.001		
CV2	1.000	1.000	1.000	1.000	0.999	1.001	0.987	1.013
Model 3							0.987	1.013
CV1	0.979	1.021	0.980	1.021	0.987	1.013		
CV2	0.993	1.007	0.995	1.005	0.991	1.010	0.971	1.030
IV1	0.963	1.038	0.960	1.042	0.970	1.030	0.961	1.040
IV2	0.981	1.020	0.979	1.021	0.986	1.014	0.969	1.032
IV3	0.926	1.080	0.921	1.086	0.945	1.059	0.989	1.011
IV4	0.919	1.088	0.906	1.104	0.941	1.063	0.942	1.061
IV5	0.870	1.150	0.851	1.174	0.906	1.104	0.938	1.067
	Stratum 5		**Stratum 6**		**Stratum 7**		**Stratum 8**	
Model 1	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
CV1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Model 2								
CV1	0.996	1.004	1.000	1.000	0.997	1.003	0.903	1.107
CV2	0.996	1.004	1.000	1.000	0.997	1.003	0.903	1.107
Model 3								
CV1	0.973	1.027	0.971	1.030	0.968	1.033	0.878	1.139
CV2	0.977	1.024	0.972	1.029	0.977	1.023	0.858	1.165
IV1	0.969	1.032	0.965	1.036	0.973	1.028	0.963	1.038
IV2	0.989	1.011	0.978	1.022	0.977	1.023	0.972	1.028
IV3	0.930	1.076	0.938	1.066	0.952	1.051	0.856	1.168
IV4	0.952	1.050	0.931	1.074	0.947	1.056	0.901	1.110
IV5	0.909	1.100	0.906	1.104	0.921	1.085	0.828	1.208
	Stratum 9		**Stratum 10**		**Stratum 11**		**Stratum 12**	
Model 1	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
CV1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Model 2								
CV1	0.998	1.002	1.000	1.000	0.971	1.029	0.998	1.002
CV2	0.998	1.002	1.000	1.000	0.971	1.029	0.998	1.002
Model 3								
CV1	0.973	1.028	0.981	1.019	0.878	1.139	0.983	1.018
CV2	0.994	1.006	0.994	1.006	0.928	1.078	0.952	1.051
IV1	0.967	1.034	0.961	1.041	0.956	1.046	0.974	1.027
IV2	0.980	1.020	0.980	1.020	0.949	1.054	0.972	1.029
IV3	0.950	1.052	0.923	1.083	0.972	1.028	0.902	1.109
IV4	0.912	1.097	0.918	1.090	0.958	1.044	0.928	1.078
IV5	0.879	1.138	0.866	1.154	0.909	1.100	0.894	1.119
	Stratum 13		**Stratum 14**		**Stratum 15**		**Stratum 16**	
Model 1	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
CV1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Model 2								

CV1	0.990	1.010	0.914	1.094	0.971	1.030	1.000	1.000
CV2	0.990	1.010	0.914	1.094	0.971	1.030	1.000	1.000
Model 3								
CV1	0.935	1.069	0.766	1.306	0.906	1.104	0.975	1.026
CV2	0.981	1.019	0.888	1.126	0.937	1.067	0.994	1.006
IV1	0.959	1.043	0.959	1.043	0.961	1.040	0.961	1.041
IV2	0.970	1.031	0.917	1.090	0.993	1.007	0.979	1.022
IV3	0.933	1.071	0.899	1.112	0.939	1.065	0.924	1.083
IV4	0.872	1.147	0.934	1.070	0.937	1.067	0.913	1.096
IV5	0.828	1.208	0.811	1.233	0.927	1.078	0.861	1.161

Appendix 16. Leverage values.

	Stratum1					Stratum 2				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.007	2.947	0.000	1.000	57040	-3.046	2.735	0.000	1.000	40234
Stud. Deleted Residual	-3.008	2.947	0.000	1.000	57040	-3.046	2.736	0.000	1.000	40234
Cook's Distance	0.000	0.001	0.000	0.000	57040	0.000	0.001	0.000	0.000	40234
Centered Leverage Value	0.000	0.001	0.000	0.000	57040	0.000	0.001	0.000	0.000	40234
	Stratum 3					**Stratum 4**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.068	2.893	0.000	1.000	17746	-2.843	2.932	0.000	0.999	4473
Stud. Deleted Residual	-3.069	2.894	0.000	1.000	17746	-2.850	2.936	0.000	1.000	4473
Cook's Distance	0.000	0.003	0.000	0.000	17746	0.000	0.006	0.000	0.000	4473
Centered Leverage Value	0.000	0.004	0.000	0.001	17746	0.000	0.018	0.002	0.002	4473
	Stratum 5					**Stratum 6**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.386	3.241	0.000	0.999	5332	-2.936	2.288	0.000	0.999	4395
Stud. Deleted Residual	-3.394	3.246	0.000	1.000	5332	-2.941	2.290	0.000	1.000	4395
Cook's Distance	0.000	0.008	0.000	0.000	5332	0.000	0.007	0.000	0.001	4395
Centered Leverage Value	0.000	0.016	0.001	0.002	5332	0.000	0.009	0.002	0.002	4395
	Stratum 7					**Stratum 8**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.429	2.619	0.000	0.999	3584	-1.713	3.205	0.000	1.000	10903
Stud. Deleted Residual	-3.442	2.622	0.000	1.000	3584	-1.714	3.207	0.000	1.000	10903
Cook's Distance	0.000	0.008	0.000	0.001	3584	0.000	0.006	0.000	0.000	10903
Centered Leverage Value	0.001	0.012	0.002	0.002	3584	0.000	0.008	0.001	0.001	10903
	Stratum 9					**Stratum 10**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-1.830	3.213	0.000	1.000	36857	-2.857	2.981	0.000	1.000	54012
Stud. Deleted Residual	-1.830	3.213	0.000	1.000	36857	-2.858	2.982	0.000	1.000	54012
Cook's Distance	0.000	0.001	0.000	0.000	36857	0.000	0.001	0.000	0.000	54012
Centered Leverage Value	0.000	0.002	0.000	0.000	36857	0.000	0.001	0.000	0.000	54012

	Stratum 11					Stratum 12				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-2.892	2.939	0.000	0.999	2918	-3.018	2.902	0.000	1.000	20463
Stud. Deleted Residual	-2.898	2.945	0.000	1.000	2918	-3.019	2.903	0.000	1.000	20463
Cook's Distance	0.000	0.014	0.000	0.001	2918	0.000	0.002	0.000	0.000	20463
Centered Leverage Value	0.001	0.022	0.002	0.003	2918	0.000	0.002	0.000	0.000	20463
	Stratum 13					**Stratum 14**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.013	2.615	0.000	1.000	23247	-2.660	2.731	0.000	0.999	5566
Stud. Deleted Residual	-3.014	2.616	0.000	1.000	23247	-2.663	2.733	0.000	1.000	5566
Cook's Distance	0.000	0.002	0.000	0.000	23247	0.000	0.004	0.000	0.000	5566
Centered Leverage Value	0.000	0.003	0.000	0.000	23247	0.000	0.007	0.001	0.001	5566
	Stratum 15					**Stratum 16**				
	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.119	3.250	0.000	0.999	4577	-3.004	3.090	0.000	1.000	53178
Stud. Deleted Residual	-3.214	3.255	0.000	1.000	4577	-3.004	3.090	0.000	1.000	53178
Cook's Distance	0.000	0.077	0.000	0.001	4577	0.000	0.001	0.000	0.000	53178
Centered Leverage Value	0.000	0.056	0.002	0.004	4577	0.000	0.001	0.000	0.000	53178

Appendix 17. Descriptive statistics.

	Stratum 1			**Stratum 2**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.2582	0.69985	57040	0.2606	0.61050	40234
CV1	0.4855	0.49979	57040	0.4822	0.49969	40234
CV2	0.7562	0.42936	57040	0.7450	0.43586	40234
IV1	0.04	0.188	57040	0.04	0.189	40234
IV2	0.02	0.136	57040	0.02	0.132	40234
IV3	0.08	0.270	57040	0.08	0.271	40234
IV4	0.10	0.298	57040	0.11	0.307	40234
IV5	0.28	0.447	57040	0.30	0.457	40234
	Stratum 3			**Stratum 4**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.7266	0.74006	17746	0.1114	1.01284	4473
CV1	0.5050	0.49999	17746	0.5209	0.53506	4473
CV2	0.7982	0.40135	17746	1.1453	0.79572	4473
IV1	0.04	0.187	17746	0.04	0.204	4473
IV2	0.01	0.115	17746	0.01	0.117	4473
IV3	0.07	0.258	17746	0.08	0.267	4473
IV4	0.09	0.282	17746	0.07	0.260	4473
IV5	0.25	0.432	17746	0.22	0.417	4473
	Stratum 5			**Stratum 6**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.5631	0.77420	5332	-0.5693	1.27331	4395
CV1	0.5212	0.49960	5332	0.4808	0.49969	4395
CV2	0.7969	0.40235	5332	0.7524	0.43164	4395
IV1	0.04	0.201	5332	0.03	0.173	4395
IV2	0.01	0.109	5332	0.03	0.171	4395
IV3	0.07	0.259	5332	0.08	0.269	4395
IV4	0.08	0.263	5332	0.08	0.272	4395
IV5	0.24	0.426	5332	0.21	0.410	4395
	Stratum 7			**Stratum 8**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.1813	0.80075	3584	0.6410	0.47436	10903
CV1	0.4768	0.49953	3584	0.5316	0.49902	10903
CV2	0.7455	0.43562	3584	0.6458	0.47830	10903
IV1	0.03	0.165	3584	0.03	0.168	10903
IV2	0.03	0.181	3584	0.01	0.108	10903
IV3	0.07	0.258	3584	0.11	0.313	10903
IV4	0.09	0.281	3584	0.10	0.294	10903
IV5	0.18	0.385	3584	0.32	0.468	10903

	Stratum 9			**Stratum 10**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.7679	0.49850	36857	0.2830	0.67274	54012
CV1	0.4882	0.49987	36857	0.4834	0.49973	54012
CV2	0.8181	0.38578	36857	0.7631	0.42518	54012
IV1	0.04	0.187	36857	0.04	0.189	54012
IV2	0.02	0.134	36857	0.02	0.137	54012
IV3	0.06	0.232	36857	0.08	0.274	54012
IV4	0.10	0.300	36857	0.10	0.297	54012
IV5	0.29	0.454	36857	0.28	0.450	54012
	Stratum 11			**Stratum 12**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.0651	0.60156	2918	0.1118	0.68623	20463
CV1	0.5476	0.49781	2918	0.5567	0.49679	20463
CV2	0.6169	0.48624	2918	0.7185	0.44976	20463
IV1	0.04	0.192	2918	0.03	0.157	20463
IV2	0.02	0.123	2918	0.02	0.149	20463
IV3	0.04	0.185	2918	0.10	0.303	20463
IV4	0.10	0.300	2918	0.08	0.273	20463
IV5	0.17	0.376	2918	0.24	0.425	20463
	Stratum 13			**Stratum 14**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.4370	0.69855	23247	0.1766	0.60629	5566
CV1	0.4730	0.49928	23247	0.4607	0.49849	5566
CV2	0.8683	0.33819	23247	0.5255	0.49939	5566
IV1	0.04	0.185	23247	0.04	0.195	5566
IV2	0.02	0.132	23247	0.03	0.170	5566
IV3	0.06	0.241	23247	0.05	0.209	5566
IV4	0.11	0.319	23247	0.08	0.268	5566
IV5	0.33	0.470	23247	0.28	0.447	5566
	Stratum 15			**Stratum 16**		
	Mean	Std.Deviation	N	Mean	Std.Deviation	N
DV	0.0951	0.57490	4577	0.2795	0.70652	53178
CV1	0.4822	0.49974	4577	0.4858	0.49980	53178
CV2	0.7754	0.49409	4577	0.7578	0.42843	53178
IV1	0.04	0.194	4577	0.04	0.188	53178
IV2	0.00	0.063	4577	0.02	0.140	53178
IV3	0.05	0.212	4577	0.08	0.274	53178
IV4	0.08	0.265	4577	0.10	0.301	53178
IV5	0.24	0.425	4577	0.28	0.448	53178

Appendix 18. Benchmarking data 2005–2020.

Year/ Budget category	Employees (SIM IT)	Contractors (SIM IT)	Consultants (SIM IT)	Hardware/ software (SIM IT)	Cyber-security (SIM IT)	Cyber-security (Ponemon)
2005	42%	4%	8%	37%		8%
2006	41%	7%	8%	36%		7%
2007	31%	19%	9%	31%		8%
2008	39%	8%	10%	37%		8%
2009	43%	12%	12%	27%		9%
2010	46%	12%	10%	26%		9%
2011	40%	5%	11%	38%		9%
2012	40%	11%	9%	34%		9%
2013	40%	10%	3%	41%		9%
2014	39%	6%	7%	33%		9%
2015	38%	6%	6%	33%	5%	10%
2016	38%	6%	7%	26%	6%	10%
2017	38%	6%	7%	28%	5%	11%
2018	35%	7%	7%	27%	8%	
2019	38%	7%	8%	26%	7%	
2020	34%	6%	8%	26%	9%	
Average	**37%**	**6%**	**7%**	**28%**	**7%**	**10%**

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