STRATEGIC MANAGEMENT OF TECHNOLOGICAL INNOVATION IN THE TELECOMMUNICATIONS SECTOR
How to choose social investment projects by calculating their efficiency of investment using agile software development techniques

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Abstract

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of science." —William Thomson[11]

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`Social Investment, Investment Efficiency, Agile Development, Net Present Value, Scrum Estimates, Web Service`

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1 Introduction

At INdT the Service Experience Group supports Community Social Investment (CSI) projects which aim to benefit society through the innovative usage of technology in Education, Health and the Environment. It is a commonly accepted fact in business such projects bring benefits to an organization. Unfortunately, even if the project is very successful this often does not impact directly on the financial bottom line. And, in a world of razor-thin margins, a set of activities that drive up corporate cost without any directly identifiable return is a tough sell, no matter how worthwhile and noble the project might be. The business case for social projects is therefore contingent on finding a suitable method for valuation — one that allows managers to understand the implications of an indirect benefit and then make 'intelligent' decisions about which projects to choose. This work is an attempt to provide such a framework and to make it both practical and intuitive to use for both managers and team members when they need to assess new projects.

2 Current Literature

A social project then can be seen as an asset to a firm - albeit an asset which is difficult to value and which is itself made up of other difficult to value intangible assets! Valuing such intangible assets is becoming increasingly important to firms as seen below

View of industry-recognised text on IP and intangible assets

"Intangible assets are all the elements of a business enterprise that exist in addition to working capital and tangible assets. They are the elements, after working capital and tangible assets, that make the business work and are often the primary contributors to the earning power of the enterprise. Their existence is dependent on the presence, or expectation, of earnings."

Source *Valuation of Intellectual Property and Intangible Assets, Second Edition*, by Gordon V Smith and Russell L Parr, 1994

which notes the primary contribution of intangible assets to the earning power of the enterprise. In standard economic theory a measure of a firms intangible assets can be seen through its Tobin's Quotient[2]. When this reflects solely the recorded assets of the company, the Tobin's Quotient would be 1.0. If the Tobin's Quotient is greater than 1.0, then the market value of the firm is greater than the value of the company's recorded assets. This suggests that the market value reflects some unmeasured or unrecorded assets of the company. It is easy to see how different this ratio is for Internet technology firms such as Amazon (6.8) and eBay (1.95) than it is for Petrobras (0.74)[3] for example.

Whilst it is a useful measure, as the Tobin's Quotient reflects a number of variables (such as market sentiment and recorded as well as intangible assets) it can only be an approximation of a true figure. Current economic methods to find a more realistic way to value intangible assets fall into three broad categories - the cost-based model, the market-based model and the income-based model. The cost model seeks to estimate value by estimating the costs of replacing the intangible asset and the market model attempts to value an intangible asset by comparing it with sales of similar assets in the market place. Both of these models fail however to take into account the dynamic nature of intangible assets and so the income based model was developed to assess the ability of an intangible asset to produce income.

In recent years this income (or present value) based model using discounted cash flows has become a popular model to use [9]. Income-based models are commonly built on future cash flow estimates associated with a particular asset. These models project future earnings and expenditures attached to the asset. Those estimates are also discounted to account for the time value of money and the uncertainty as to the accuracy of the projected cash flow. The Net Present Value (NPV) of the future earnings is calculated so that the estimated potential value of the asset can be compared with similar estimates for other potential projects, and current resource allocation decisions can be made based on comparative future value of different projects.

When building our own tool we thought that this kind of income model offered the best foundation for us to accurately examine and compare social projects. Indeed there is a recent precedent for using the income based model when calculating the Social Returns on an Investment (SROI)[7]. The SROI project (undertaken by the Cabinet Office of the Third Sector of the UK Government) is a tool for measuring social, environmental and economic outcomes which uses monetary values to represent these outcomes. It uses a cost/benefit analysis to arrive at a value for the NPV and subsequently for the SROI. This is the same method we are using however we are using scrum 'sizings' (see below) as a proxy for monetary values.

We are doing this because it seemed obvious to us that income-based models function best when there is accurate information to support the future income and cash flow projections. Such information is more likely to be available when the asset or project in question is either very similar to one already in the marketplace or *when the team that is running the sizing is familiar with the type of asset or project being assessed.*

3 Method and Definitions

3.1 Overview

Our work then starts from the premise that the intangible value of a CSI project can be measured. To do this we will use an innovative 're-appropriation' of an agile software development technique called a 'Scrum Estimate' (which in our work we are calling a 'Scrum Sizing') run by team of subject matter experts familiar with CSI work. They will first read the business case for a project and then estimate (using a process called Iterative Sizings) values to answer questions selected from a backlog. These values will be passed to algorithms which calculate whether the project is efficient in terms of the investment necessary to realize the project.

3.2 Scrum Sizings

A scrum sizing is a consensus-based estimation technique, mostly used to estimate effort or relative size of tasks in software development. It is a variation of the Delphi method first used in the 1940's at the RAND corporation[10]. It is based on a list of features to be delivered (or questions to be answered in our case) and several copies of a deck of numbered cards. A typical deck has cards showing the Fibonacci sequence[6] such as 0, 1, 2, 3, 5, 8, 13, 21 and so on. The reason for using the Fibonacci sequence is to reflect the inherent uncertainty in estimation.

To start the team first reads the business case for a social project and then the first item is read out from the selected backlog (represented as a list of questions). Each participant assigns a value from the deck of cards in response to the question. The participant with the highest and the lowest estimated values then must present their reasoning to the rest of the group. After this the group estimates again until consensus is reached

Assigning values in this way allows the relative weighting values to be aggregated and passed to algorithms which calculate figures for Net Present Value (NPV) and for Investment Efficiency (IE)- which is more commonly known in business economics as the 'Bang for Buck' [5] measurement. With this measurement in hand it is then possible to rank CSI projects in terms of the best social and business return per hypothetical dollar invested.

3.3 Algorithms

A goal of our work then is to have a rank ordered list where the projects at the top of the list score highest against achieving the objectives we have reflected in our selected backlog.

A challenge with this is to determine a consistent, valid and reliable method of valuing projects. A straightforward value maximization tool is Net Present Value (NPV)[1]and this is the difference between the sum of the discounted cash flows which are expected from the project and the amount which was initially invested. The steps to calculate it are

- Calculate the expected cash flows that result from the investment
- Subtract the cost of capital - this is normally the interest rate and in our algorithm we have used the term WACC for this (Weighted Average

Cost of Capital)

- Subtract the Initial Investment

This is represented in source code as

```
def npv(rate, cashflows):
    """The total present value of a time series of cash flows.

        >>> npv(0.1, [-100.0, 60.0, 60.0, 60.0])
        49.211119459053322
    """
    total = 0.0
    for i, cashflow in enumerate(cashflows):
        total += cashflow / (1 + rate)**i
    return total
```

If the NPV value returned is positive then (given unlimited resources) all projects with a positive NPV in any given portfolio of projects will get the go ahead. The problem comes when we consider the fact that in the real world resources are not unlimited. The goal then becomes to maximize the total NPV or economic value of the whole portfolio of projects subject to a **resource constraint**. The way to do this is to take the ratio of the item we are trying to maximize (NPV) and divide it by the constraining factor (resources). This is represented in source code as

```
print "    IE: %s" % (_npv/resources)
```

and is referred to as Investment Efficiency (IE). Using our tool social projects with a higher IE will be ranked above projects with a lower IE.

3.4 Business case

For each project a Business Case was entered onto our system. As well a being a requirement that all projects at INdT have a Business Case it also provides both context and scope for our sizing team to use when sizing. Each CSI project Business Case contains the following information:

- What is the opportunity?
- Who are the potential global and local customers?

[1]The code in the Appendix also refers to something called the IRR(Internal Rate of Return). Calculating this allowed us to verify that the code which subsequently calculated the NPV was working correctly

- What differentiates this solution when compared to any other?
- What constraints are there in relation to this opportunity?
- What is the market potential?[2]
- What is the strategic alignment of the project
- What tools and competencies are necessary to bring the solution to life?
- What are the components of cost (both one time and recurring)?

3.5 Iterative Sizing

Reviewing the business case made it possible to run an Iterative Sizing session for a project. An iterative sizing comprises the following steps:

- Each participant is given a deck of 'Planning Poker' cards
- Sizing team reads a CSI Business Case
- Sizing Master selects an item from the Selected Backlog
- Everyone selects an estimate card
- Cards are turned over so all can see them
- Discuss differences (especially outliers)
- Reestimate until estimates converge

This is done for each question in the Selected Backlog.

3.6 Selected Backlog

The items in the *initial* selected backlog were chosen on their contributions to INdT 2011 business objectives. Specifically, these objectives are[8]

- Sales/cost saving generated by INdT originated services/products in Brazil: 71M BRL

[2]The market potential in terms of a CSI project refers to how many people directly benefit from the project

- Nr of concepts/products created: 1 with a greater than 100M sales potential, 2 with 50-100M
- Nr of patents, high degree graduates and scientific publications created: 50

Our first attempt at a selected product backlog produced this:

- The cost to set the project up
- A value which expresses the number of new customers gained by Nokia because of the project
- A value which expresses how much the project aligns with INdT strategy
- The value added to INdT core *technology* competencies (compared to the cost if this was provided through external training)
- The value of the Intellectual Property Rights the project might bring to INdT
- A value which expresses the number of partners more likely to collaborate with INdT because of the project
- A value which expresses the number of new projects that Nokia will partner with CI/INdT because of the project
- A value which expresses the new skills and knowledge the project brings to employees of INdT
- What is the value of any remaining costs after the project has been implemented

and tests were run using our algorithms with this selected backlog (see the results section below).

It was noted during feedback that we were focusing our questions in this selected backlog more on business objectives and not the benefits to society. Changing our selected backlog however has certain implications for the 'owner' of a project. A social project can simply be assessed (as we were doing initially) on the additional value it brings to a firm in terms of its trademark,logo or adherence to strategy. This is of course quite independent of the intrinsic value of a project to society. Trying to measure this intrinsic value (as well as the benefit to the owner) was something we hoped to reflect in the second iteration of our selected backlog. This was

3.6.1 Second Iteration

- The cost to set the project up
- A value which expresses the number of new customers gained by Nokia Brazil because of the project
- A value which expresses the contribution of this project to the sustainability of INdT.
- A value which expresses the amount of goodwill generated towards INdT because of this project
- The value of the Intellectual Property Rights the project might bring to INdT
- A value which expresses the number of partners more likely to collaborate with INdT because of the project
- A value which expresses the reduction in environmental degradation due to this project
- A value which expresses how much peoples wellbeing might be improved because of this project
- What is the value of any remaining costs after the project has been implemented

again feedback on this selected backlog identified a problem with the following questions

- A value which expresses the reduction in environmental degradation due to this project
- A value which expresses how much peoples wellbeing might be improved because of this project

as it might be difficult to ensure objectivity from the team during the sizing. For these questions we needed to establish baseline indicators which we could use for both environmental impact and human development. For this we used the Ecological Footprint[3]and Human Development Index(HDI)[4][4] which were specifically developed to be used as indicators for environment and poverty reduction strategies. The selected backlog was then modified and the two questions became

- Relative to the scope of the projects current Ecological Footprint, estimate a value for a new Ecological Footprint due to this project
- Relative to the scope of the projects current HDI, estimate a value for a new HDI because of this project

4 Results

Below is the first sizing done by the CSI team for the Nokia Data Gathering (NDG) project

This is not a prospective project (it is already a successful project at INdT) however it was used initially as it allowed the weightings on the algorithms

[3]The Ecological Footprint measures the actual throughput of renewable resources relative to what is annually renewed. It is a given areas ability to sustain itself.

[4]HDI combines three measurements - GDP,Life Expectancy at Birth and the Adult Literacy rate

to be adjusted for bias and allowed us to fine tune the items selected from the product backlog.Running the sizing gives a sequence of values like

WACC	Initial Cost	Number of New Customers	Alignment with INdT Strategy
0.045	-64	8	16

and when run through the algorithms gave results of

- NPV: 29.1276808524
- IE: 3.64096010656

During the MBA class on Empreendedorismo e Prática em Plano de Negócios we had a further chance to test our algorithms and weightings. Our Service Experience group chose to focus on a future project called Surveys which is due to start in 2010. We ran both a conventional financial analysis (based on estimated costs) and a sizing using our tool on it. We then compared the results. The financial analysis gave an IE figure of 1.91 and the sizing gave an IE of 10.88 (both figures were calculated using our algorithms). It will be interesting to see after the survey project is up and running which figure is closer to the actual investment efficiency of the project.

We suspect that members of a sizing team simultaneously both overestimate benefits and underestimate risk. This bias problem is well recognised in the literature as the 'systematic tendency for people to be over-optimistic about the outcome of planned actions'[1]. If this does prove to be the case it should be trivial to tweak our algorithm to compensate.

The system outlined here has been implemented as a web service and is available at

`http://guarda-chuva.com`

Please visit the site for more details about the service (a password is required)

5 Conclusion

It seems important for the effectiveness of the algorithm that the sizing team be experienced with the type of project being evaluated. It is also very useful for the teams to run sizings and to talk through the answers to the questions after having read the business plan. This is not only in terms of reaching a consensus value for the particular item in the selected backlog but also in terms of dispelling the often fixed ideas that team members bring to the project - "Really, you thought it would cost that much?" - for example.

Clearly the questions which comprise the selected backlog are crucial. These questions are of course customisable and can be modified if a manager wants more emphasis towards a particular strategy area. Our method is flexible enough for a manager to be able to ask the service *"According to these specific questions about a portfolio of projects show me a ranking of the projects in terms of their efficiency of investment"*. This is quite a nice feature to have.

It remains to be seen whether the actual tool itself has value to INdT. All indications are that the agile techniques we borrowed from software development allow us to deal very well with the uncertainty implicit in social projects and that the numerical techniques we borrowed from business development can make our investment decisions more efficient. Further trials will be done but whatever the outcome of those it is clear that our system allows for greater transparency at all levels within a project team and that has to be a good thing for INdT.

6 Bibliography

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APPENDIX

```
#!/usr/bin/env python
# Copyright (C) 2008 Instituto Nokia de Tecnologia. All rights reserved.
# Contact: Ian Lawrence ian.lawrence@openbossa.org
#
# This software, including documentation, is protected by copyright
# controlled by Instituto Nokia de Tecnologia. All rights are reserved.
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# or all of this material requires the prior written consent of
# Instituto Nokia de Tecnologia. This material also contains
# confidential information which may not be disclosed to others without
# the prior written consent of Instituto Nokia de Tecnologia.
#
#===========================================================================
'''
A set of functions for quick financial analysis of an investment
opportunity and a series of projected cashflows. This is the standalone version

For further details and pros/cons of each function please refer
to the respective wikipedia page:

    net present value
        http://en.wikipedia.org/wiki/Net_present_value

    internal rate of return
        http://en.wikipedia.org/wiki/Internal_rate_of_return

    efficiency of investment
        net present value/cost -> the return to be expected per unit of investme
'''

import sys, locale

def payback_of_investment(investment, cashflows):
    """The payback period refers to the length of time required
       for an investment to have its initial cost recovered.

       >>> payback_of_investment(200.0, [60.0, 60.0, 70.0, 90.0])
       3.1111111111111112
    """
```

```python
    total, years, cumulative = 0.0, 0, []
    if not cashflows or (sum(cashflows) < investment):
        raise Exception("insufficient cashflows")
    for cashflow in cashflows:
        total += cashflow
        if total < investment:
            years += 1
        cumulative.append(total)
    A = years
    B = investment - cumulative[years-1]
    C = cumulative[years] - cumulative[years-1]
    return A + (B/C)

def payback(cashflows):
    """The payback period refers to the length of time required
       for an investment to have its initial cost recovered.

       (This version accepts a list of cashflows)

       >>> payback([-200.0, 60.0, 60.0, 70.0, 90.0])
       3.1111111111111112
    """
    investment, cashflows = cashflows[0], cashflows[1:]
    if investment < 0 : investment = -investment
    return payback_of_investment(investment, cashflows)

def npv(rate, cashflows):
    """The total present value of a time series of cash flows.

        >>> npv(0.1, [-100.0, 60.0, 60.0, 60.0])
        49.211119459053322
    """
    total = 0.0
    for i, cashflow in enumerate(cashflows):
        total += cashflow / (1 + rate)**i
    return total

def irr(cashflows, iterations=36):
    """The IRR or Internal Rate of Return is the annualized effective
       compounded return rate which can be earned on the invested
       capital, i.e., the yield on the investment.
```

```
        >>> irr([-100.0, 60.0, 60.0, 60.0])
        0.36309653947517645

    """
    rate = 1.0
    investment = cashflows[0]
    for i in range(1, iterations+1):
        rate *= (1 - npv(rate, cashflows) / investment)
    return rate


# enable placing commas in thousands
locale.setlocale(locale.LC_ALL, "")
# convenience function to place commas in thousands
format = lambda x: locale.format('%d', x, True)

def investment_analysis(discount_rate, cashflows, resources):
    """Provides summary investment analysis on a list of cashflows
       and a discount_rate.

       Assumes that the first element of the list (i.e. at period 0)
       is the initial investment with a negative float value.
    """
    _npv = npv(discount_rate, cashflows)
    ts = [('year', 'cashflow')] + [(str(x), format(y)) for (x,y) in zip(
           range(len(cashflows)), cashflows)]
    print "-" * 70
    for y,c in ts:
        print y + (len(c) - len(y) + 1)*' ',
    print
    for y,c in ts:
        print c + ' ',
    print
    print
    print "Discount Rate: %.1f%%" % (discount_rate * 100)
    print "Remaining Expenses: %s" % resources
    print
    #print "Payback: %.2f years" % payback(cashflows)
    print "    IRR: %.2f%%" % (irr(cashflows) * 100)
    print "    NPV: %s" % format(_npv)
```

```
    print "    IE: %s" % (_npv/resources)
    print
    print "==> %s opportunity which has a one time cost of %s" % (
        ("Approve this" if _npv > 0 else "Do Not Approve this"), format(-cashflo
    print "-" * 70

def main(inputs):
    """commandline entry point
    """

    usage = '''Provides analysis of a business opportunity from a series of cash

    usage: juiz WACC [cashflow0, cashflow1, ..., cashflowN] Remaining Expenses
        where
            WACC is Weighted Average Cost of Capital
            cashflow0 is the investment amount (always a negative value)
            cashflow1 .. cashflowN values can be positive (net inflows)
                                                 or
                                                 negative (net outflows)
            Remaining Expenses is the capital which remains to be spent on the p

    for example:
        juiz 0.09 -10000 6000 6000 6000 2000
    '''

    try:
        rate, cashflows, resources = inputs[0], inputs[1:-1], inputs[-1]
        investment_analysis(float(rate), [float(c) for c in cashflows], float(re
    except IndexError:
        print usage
        sys.exit()

if __name__ == '__main__':
    debug = False
    if debug:
        import doctest
        doctest.testmod()
    else:
        main(sys.argv[1:])
```