PGPEX

BUSINESS REVIEW

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INDIAN INSTITUTE OF MANAGEMENT CALCUTTA

Director's Message

It gives me great pleasure in introducing the first edition of the PGPEX online newsletter, *PGPEX Business Review*, the first of its kind from the current batch of PGPEX.

This year the Institute has taken many initiatives and this is a good time for launching the newsletter. Indian Institute of Management Calcutta has become the first IIM in the country to receive accreditation from AACSB (Association to Advance Collegiate Schools of Business) International. Now it becomes the only B-school in India with both the AACSB and AMBA (Association of MBAs) accreditations. Through Accreditation, IIM Calcutta has not only met specific standards of excellence, but has also made a commitment to ongoing improvement to ensure that the Institution will continue to deliver high quality education to its students.

The restructuring of the PGPEX curriculum has been completed finally and is to be effective from the Academic Session 2015-2016. Individual research projects, introduction of pre work and workshop modes of teaching, live projects within a course will be encouraged in the revised curriculum. PGPEX students with their understanding and appreciation of Indian and global economic and societal realities along with their rich and diverse domain experience have contributed articles for this magazine which are current topics of interest and I am sure you will enjoy reading them.

I congratulate the PGPEX students on their new endeavour and hope this will be a continuous effort from their team.

Saibal Chattopadhyay.
Director
IIM Calcutta

FROM THE
EDITORS' DESK

Dear Readers,

Welcome to the inaugural issue of *PGPEX Business Review* – a quarterly write up of management articles presented by the PGPEX Class of 2015 at IIM Calcutta. With a cumulative work experience of about 400 years across a variety of sectors, there was no paucity of ideas among the students.

We thought it fitting to focus our inaugural issue on areas of social significance. Can business organisations sustainably and perhaps profitably, service the needs of the poor in the country? If there is indeed a fortune at the bottom of the pyramid, how can business organisations tap it? What help do we require from the government for this? How can organisations measure the impact of their CSR activities? These are some of the issues that our inaugural issue looks to address.

We hope you will find the articles in the *PGPEX Business Review* insightful, engaging and stimulating. Your thoughts and comments are most welcome as we strive to shape this exciting new venture into one that will add value to every reader. Please e-mail us at **pgpexconnect@email.iimcal.ac.in** with 'PBR' in the subject with your suggestions.

Fahd Fakih   Raghvendra Upadhya

> **"** Freshly armed with management ideas from the classroom, our goal is to bridge the gap between academia and industry through articles that we have compiled from faculty, students and alumni. **"**

SOCIAL **IMPACT** BONDS

Government of India spends billions of dollars every year in social projects to address serious social and environmental problems (e.g., school dropout rate, infant mortality, environmental pollution, rural electrification etc.). The major challenge for the government is to assess the effectiveness of the programmes. What is the guarantee that the money disbursed actually reaches the beneficiary? How do you ensure the outcome of a project? Several laudable experiments, on social issues, fail and taxpayers legitimately question government not to spend their money on 'failed' experiments. The pragmatic governments, therefore, would want to spend money on successful experiments. Tax payers also would not mind that spending.

An innovative financial vehicle is developed mainly to address this concern. Social Impact Bonds (SIBs)—also known as "social innovation financing" or "pay for success"—offer governments a risk-free way of pursuing creative social programs that may take years to yield results. Usually, governments decide what problems they want to address and then enter into a contractual agreement with an interm-mediary (or bond-issuing organization) that is responsible for raising capital from independent investors including banks, foundations, and individuals, and for hiring and managing nonprofit service providers. If the project achieves its stated objectives, the government repays the investors with returns based on the savings the government achieves as a result of the program's success.

Payment is based on what the project or service has achieved and not on the processes or work that have been done. *Figure 1* shows how traditional SIBs work: initial funding is paid for by investors to cover the costs of the project. The provider carries out the project, and the investor is paid by the government according to the results achieved, at specific points agreed in the contract. For example, if a state government wants to reduce school dropout rate in the state, SIBs can be used to raise funds from private philanthropists and if the service provider (the agency engaged to work with the schools) can ensure that the dropout rate did reduce below a threshold, the state government would pay the investors the principal back along with some returns at times.

The fund manager (social impact bond issuer) has a critical role to play. She has to identify and approach high net worth individuals, foundations and even some corporates to subscribe to the SIBs. Next, she needs to know the service providers (NGOs and/or social enterprises) who have access to the beneficiaries and have organizational set up and programmes to deliver results. The fund manager also has to liaise with the government and finalise terms of repayment. The structure of SIBs is such that investors do not consider their investments as charity and assurance from government on repayment of the bonds actually enhance the creditworthiness of issuers.

> *Social Impact Bonds (SIBs)—also known as "social innovation financing" or "pay for success"—offer governments a risk-free way of pursuing creative social programs that may take years to yield results.*
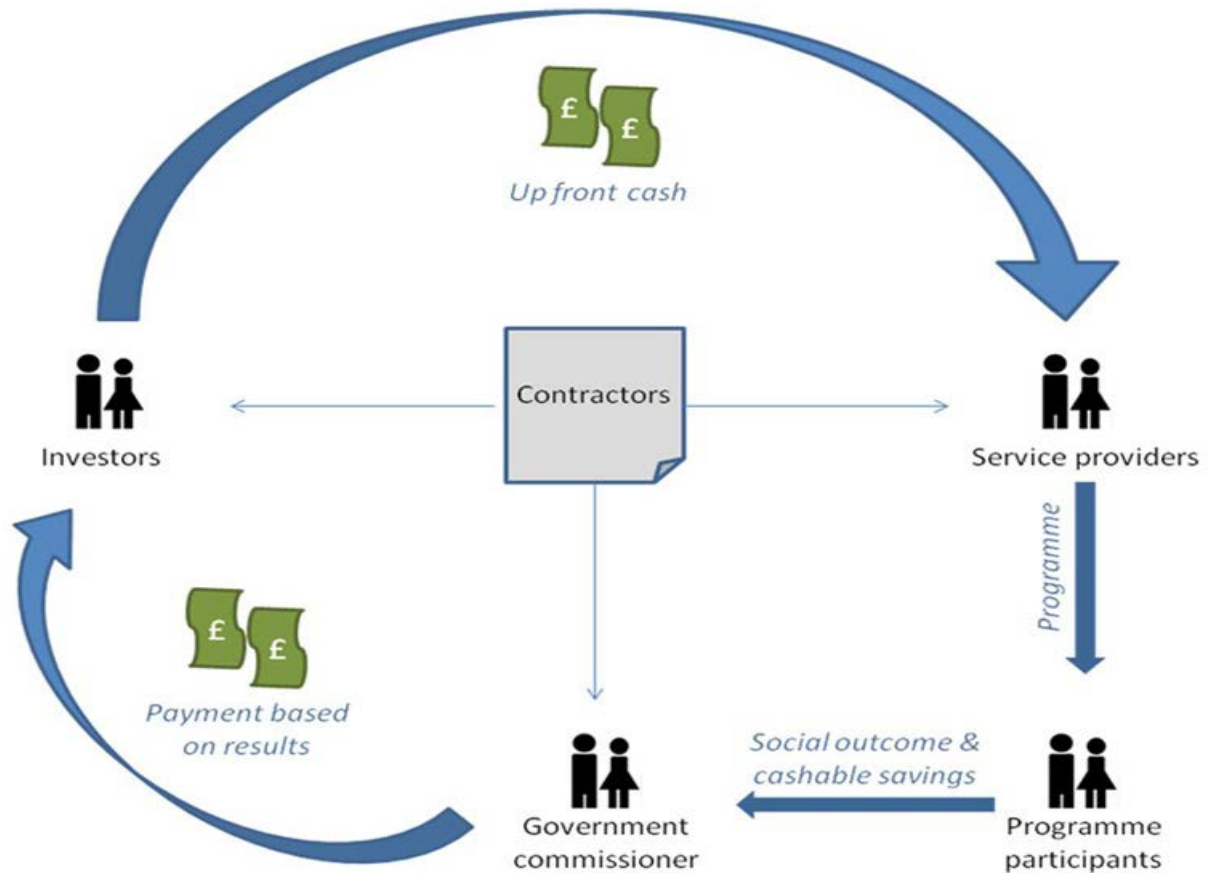
Figure 1   *Source: https://www.gov.uk/social-impact-bonds*

The first Indian organization to use SIBs to launch a Pay By Results (PBR) programme was Educate Girls- a Dasra portfolio organization. Dasra is a philanthropic foundation working with philanthropists 'to create large scale social change'. Existing donors contributed to the Educate Girls programme to achieve the following outcomes: a) increased enrolment of girls in school; b) increased attendance in school and continued enrolment over several years; c) improvement in learning and test scores. Unlike traditional SIBs where ultimately government 'buys' the outcome and repays the original investors, Dasra SIB is structured in such a way that existing donors will continue to fund the programme till the outcomes are achieved. Once the outcomes are achieved 'buyers' of the results i.e., new donors (mostly from overseas) will put in money to expand the services and reach of the programme. Hence, the existing donors will not get their investment back (another deviation from a traditional SIB route).

SIBs as a financial instrument has the potential to become a popular way of finding social and environmental projects where results cannot always be monetized. Companies in India, who are required to spend 2% of their three-year average after-tax profits on CSR (Corporate Social Responsibility) projects can avail this route to ensure that they pay for results. This way impact assessment of social investments can be ensured.

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*(The author acknowledges the support of **Ms. Ity Kanoria,** Trainee research associate in the Finance Lab, in preparing the article.)*

Bandhan Financial Services was set up in 2001 to address the dual objective of poverty alleviation and women empowerment.

IIM Calcutta PGPEX students had the opportunity of interviewing Mr. Chandra Shekhar Ghosh, Chairman and Managing Director, Bandhan.

MICROFINANCE: THE **BANDHAN** WAY

Why don't commercial banks lend to near zero income groups? Is it because of the lack of collateral/ security?

For low-income individuals, either they don't have assets or their assets (e.g. the house where they stay) are not treated as collateral / security by commercial banks. But do they have potential? Yes, of course they do. It depends on the mentality of the bank to understand and evaluate the credit-worthiness of the individual. Most financial institutions in India are happy lending to the top 10%

Micro Finance Institutions (MFIs) treat those bottom layer individuals as potential customers and create a viable business model out of extending credit to them.

The viability, however, depends on evaluating the

borrower's need and unveiling its business potential rather than validating her current asset credibility. The evaluation is a 4-step process to understand:

- the borrower's purpose/motivation in seeking a loan
- the area in which he/she would like to work
- basic credibility of the individual in his village/ neighbourhood
- Know Your Customer (KYC) – as per statutory guidelines

How does Bandhan mitigate the risk associated with lending?

You will be surprised to know that, so far, Bandhan has managed to keep the bad debt at a meagre 0.07%

• Bandhan ensures that only one loan is given to a person at a time. Generally the repayment period is within a year.

• Bandhan staff assesses the potential borrower's credibility and evaluates the realistic amount of credit needed. "To me, this is a critical success factor. If you lend Rs. 3,000 to an individual needing Rs. 30,000 and vice versa, both will default," says Mr. Ghosh.

• The representative visits the borrower within 15 days from the day of disbursement to check whether the funds are being used properly and again within 15 days after the loan has been repaid to understand future requirements, if any.

• Staff are selected and appointed in such a way that their working area is at least a 2 hour commute from where they stay. This ensures unbiased loan disbursement and collection.

• Encouraging group collection / transactions

• **Employing HTMs not ATMs**

For an Automated Teller Machine (ATM), the operational monthly expenses are around Rs. 30,000 including rent, electricity, security, transport of cash, servicing etc. The cost per transaction is calculated as Rs. 13.

The average Monthly Salary of a loan officer (or Human Teller Machine) is Rs. 10,000 only.

Consider a staff servicing 4 groups per day with 25 working days in a month, break-even will occur at Rs. 100 (i.e. Salary of Human Teller 10,000 / (4 times 25)). This means that even 10 borrowers at Rs. 10 per borrower's transaction cost can reach the break-even. In reality, the number of customers is much more which brings down the unit transaction cost even further.

> "The transaction cost at Bandhan is higher than commercial banks but lower than other MFIs."

• Stronger bonds develop between individuals having similar background, income and language. Bandhan acknowledges this and encourages such person-person bonding.

How does Bandhan keep transaction costs down?

The transaction cost at Bandhan is higher than commercial banks but lower than other MFIs. When an individual goes to the bank, his cost of transportation (howsoever minimal) is not borne by the bank, whereas MFI collectors go to the individuals and hence the cost of transportation is incurred by the MFI rather than the borrower. This works to the borrower's advantage however throwing tremendous challenge on Bandhan to reduce the cost of transaction.

Bandhan reduces the transaction cost by:

• Employing the right person for the job e.g. graduates employed through competitive exams at commercial banks want high salaries and / or facilities for rural postings. The field staffs at Bandhan are employed from among the strata of society they serve. Their salary / facility expectations are lower and they better understand the needs of the borrowers and also develop much closer relationships.

How is the staff motivated at Bandhan?

All employees are permanent with salary, provident fund, and gratuity. A Loan Officer reports directly to his/ her Branch Manager.

Total employee strength: 13,280 (July, 2014)
Loan officers: 10,000+

Bandhan understands the importance of change

management, especially after recently obtaining an approval for 'in-principal banking licence' from the Reserve Bank of India. It encourages team involvement and ensures transparency and effective communication across the organizational structure since inception.

Most of the staff members have a basic level of education. Due to lack of suitable employment opportunities, they use to sit idle and were not regarded well by society. In Bandhan, they are trained loan officers with permanent employment and salary. Not only they earn livelihood for themselves and family, they also gain respect from society. One of the staff members said, "When I go to remote areas as a staff member of Bandhan, everybody says Namaste. This keeps me motivated".

How did the recent economic recession affect Bandhan?

There was no direct affect as the impact of the recession at the bottom level of the pyramid was much less than at higher levels. However, when the real-estate sector was hit by the recession, many labourers were laid off from their job and couldn't send money back home. This had an indirect effect.

What regulatory or policy support does Bandhan require from the Government?

MFIs are often indistinguishable from chit-funds for the public. People are still quite reluctant to deal with them especially due to recent cases of chit-fund scams. Government policies and regulations should support MFIs in creating a general awareness about the sound credibility of MFIs. The recent recognition from the Reserve Bank of India in the form of an approval for 'in-principal banking licence' for Bandhan acts as a pat on the back and is a step in the right direction.

What are Bandhan's plans for business expansion?

Bandhan plans to expand its business in clusters, but as an amoeba and not as a frog. The organization believes that until and unless it has covered at least 60% of an area, it will not be able to bring the impact and level of development required.

The organization wants to leverage on the strong network that it has developed across rural area in other sectors.

As interviewed by:
Abhisek Bhattacharya and **Raghvendra Upadhya**
PGPEX 2015

BANDHAN EFFECT

A woman in Bagnan, Howrah district of West Bengal, was stranded with two daughters after her husband passed away. She borrowed Rs. 3,000 rupees to set up her own tailoring shop. A year later, she has not only repaid the loan, but also made a net savings of Rs. 27,000. Her younger daughter is in XI standard while the elder one is now studying in a college in Kolkata.

BENEFITS OF USING **LOGICAL FRAMEWORK APPROACH** IN THE SOCIAL DEVELOPMENT SECTOR

In India with wide spread inequality and contrasting realities, work in the field of social development is a focus area for stakeholders that include government, donors, social activists and social organizations, Non Governmental Organisations (NGOs), socially responsible private organizations and international development organizations. According to a recent article in *Wall Street Journal*, since the year 2000 a few segments that have attracted large foreign investments in the social sector include those for underprivileged education, healthcare for the poor, microfinance, financial inclusion, development of social entrepreneurship etc. The new Corporate Social Responsibility (CSR) Bill to reserve 2% profits of public enterprises towards CSR activities is expected to further fuel the growth of the social sector in India.

A pertinent question is: what do social development activities achieve? Can we measure performance outcome of social development work effectively? Does the CSR framework have broader implications for the private sector?
Measuring the effectiveness of social development work is important for the following reasons:

- The recipient of the aid or support program such as the underprivileged section of the population being targeted under the particular scheme may have an interest in knowing the extent to which their situation will be improved as a result of social development effort. They can provide timely feedback for any course-correction as well as help donors/stakeholders to keep a check on efforts by implementation partners.

- Donors as well as implementation partners need to know whether the resources they invest in the activities have indeed made the greatest possible contribution towards achieving pre-determined goals e.g. poverty reduction / health care coverage etc.

- Local as well as national and international development organizations have a need to learn from their experience and clearly know what works and what doesn't work in a local setting to continuously improve their social development programmes.

One such monitoring and evaluation method for development projects was introduced in United States in the 1960s called 'Logical Framework Approach (LFA)' which was extensively adopted by most of the developmental agencies across the globe including United States Agency for International Development (USAID), German Development Organization (GTZ) and the World Bank.

Several bilateral and multilateral agencies and many NGOs have made this framework a mandatory standard for project planning and project management since the 1980s. The logical framework matrix consists of 16 fields divided into different areas. The matrix consists of a causal chain of results, hierarchy of objectives and intervention logics. In the planning phase, the matrix is used to elaborate the project design or the logical model, step by step. This model is used as a basis for designing detailed tasks in project life cycle management such as annual operation planning, monitoring, reporting and evaluation.

For many people the advantage of LFA is that it forces people to carefully think through what they are planning to do and create a hypothesis aimed at change for the ultimate beneficiary, which has to be proved. LFA can encourage transparency and flexibility in planning a project with stakeholders. It is a powerful way to focus ideas, coordinate resources and pinpoint future difficulties and opportunities.

In the logical framework matrix *(Table 1)*, the first column has a hierarchical project causal chain at four levels. It starts with the direct effect / outcome of the project. At the two lower levels, there are outputs and activities enumerated that the project will provide in order to achieve the project outcomes.
At the highest level is the project goal or the long term structural change which the project is expected to achieve or contribute to. The stringency of causal relationship between the four levels decreases from bottom to top as external influences increase at each level of the log-frame (i.e. the matrix).

The key element of determining effectiveness of the project design is effectiveness of the causality between levels of outcomes and outputs. The second and third columns capture indicators that make it possible to monitor

achievements independently and objectively.

Although they are already identified at the planning stage, these parameters could be adapted or modified during course of implementation. As no indicators are necessary to monitor project activities, the corresponding field in the matrix is used to capture required input resources.

In the fourth column, identification of external factors or risks helps to give assurance about a causal relationship between two consecutive levels under absence of risk materialization.
The core of the Logical Framework is the logic model that runs through the matrix in the form of a series of connected propositions:

~ If these Activities are implemented, and these Assumptions hold, then these Outputs will be delivered
~ If these Outputs are delivered, and these Assumptions hold, then this Purpose will be achieved.
~ If this Purpose is achieved, and these Assumptions hold, then this Goal will be achieved.

Critics of the LFA note that the underlying logic model is too simple for the complex realities encountered in the field. They add that the LFA encourages blinkered vision and allows little flexibility. In practice, log frames (i.e. the matrix) are often filled out without going through the whole planning process, which defeats the methodology. The LFA is occasionally criticised for being based on an exclusively western way of thinking and therefore not very suited to other cultures.

Despite some criticism, the LFA has become a key project management and strategic planning tool for the public or the social sector. It is also useful for the planning of several private sector projects, especially when lack of clarity of objectives presents challenges, which if not addressed may lead to project failure.

PERTINENT QUESTIONS TO BE ASKED

- *What do social development activities achieve?*

- *Can we measure performance outcome of social development work effectively?*

- *Does the CSR framework have broader implications for the private sector?*

		Hierarchy of Objectives	Indicator	Means of verification	Assumptions (external factors / risks)
Effects of project	**Long Term Vision**	**Goals / overall objective** Improvement in the living condition of people and/or in the situation of natural resources to which the project makes a contribution *(broader targeted impact)*	Key indicators related to the overall goal	Sources of information for indicators / methods to get this information?	External factors to sustain overall objectives in the long term
	Direct Effect	**Project objective / outcome / purpose** Changes in the behaviour and in the capacities of key persons, people and/or organizations (target group) *(Utilization of project outputs, adoption of improved practices and changes of attitude)*	Indicate benchmark indicators to prove whether intended changes in the behavior and capacities have been achieved	Sources of information for indicators / methods to get this information?	Factors and conditions are necessary to achieve outcome towards goal
Operation domain of project		**Outputs** Products and services provided by the project *(training on new knowledge, skills and attitude, improved or new technologies, new tools, new equipment, new methods, resources, infrastructure etc.)*	Indicate benchmark indicators to prove whether project outputs have been provided in sufficient quantity and quality	Sources of information for indicators / methods to get this information	External conditions required to obtain expected outputs on schedule towards objective
		Activities Set of project activities to provide the outputs. A group of activities can be mapped to each of the project outputs.	**Means / costs** Financial, material and human resources means as well as their costs		Pre-conditions before the action starts to provide outputs

UTILITIES OF LFA

LFA is useful for the planning of several private sector projects, especially when lack of clarity of objectives presents challenges, which if not addressed may lead to project failure.

LFA can encourage transparency and flexibility in planning a project with stakeholders. It is a powerful way to focus ideas, coordinate resources and pinpoint future difficulties and opportunities.

The LFA communicates the essential elements of a complex project clearly and succinctly throughout the project cycle.

In a research carried by Booz Allen Hamilton in 2006, it was empirically demonstrated that for private sector projects in oil and gas companies in UK, adopting LFA has increased the success rates of projects.

When applied within an organization, the LFA can be a means of articulating a common interpretation of objectives of a project among all stakeholders and how these will be achieved.

The LFA has the power to communicate the essential elements of a complex project clearly and succinctly throughout the project cycle. It is used to develop the overall design of a project, to improve the monitoring of project implementation and to strengthen periodic project evaluation.

The adoption of LFA by private organizations, its customization and coupling with a few other project management techniques offers a more promising future for project management.

Written by:
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PGPEX 2015

IS **DISCOUNTING** THE ONLY WAY TO SUSTAIN AN E-COMMERCE BUSINESS?

Each one of us has at some point or the other shopped online. While for a certain section of people, shopping online has been about convenience or variety; for a majority of e-commerce customers, buying online means promo codes, discounts and savings. Unlike offline shopping, there is very little loyalty to one particular store when it comes to buying online.

Many a time, this may be because what is being sold online is a pure commodity and irrespective of where it has been bought from, the product remains identical. At other instances, the customer wants to be rewarded for saving the seller the cost of human interaction. Another store is just a click away for the customer. So, does that mean that the only way to grow an e-commerce business is through discounting? How would such a business manage to make money? How far would the investors go in sinking money to acquire new customers, in the hope that this will translate into customer loyalty?

According to a recent study, attracting new customers costs online vendors at least 20% to 40% more than it costs vendors serving an equivalent traditional market. No wonder, increasing the percentage of loyal customers by as little as 5% can increase profitability by as much as 30% to 85%, depending upon the industry involved.

The reason for this is two fold. Not only are loyal customers more prone to make frequent purchases, they are also typically willing to pay a higher price and are more understanding when something goes wrong.

A good purchase experience for the first few times ensures the customer stays with the company for the entire customer lifecycle.

But the question remains that if everyone is selling the same product on their portal, can there really be product differentiation? Is there more to it than just luring customers at the cost of burning the investors' pockets?

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The good news is that there indeed are a couple of factors where e-commerce companies can ensure the customer stays with them for the entire lifecycle. The bad news is that when it comes to these key factors, most companies do not pay adequate attention.

First and foremost, the e-commerce company must provide a good online shopping experience on its website as this is the first touch-point for the customer. What a sales manager is to an offline store, a company's website is to an online customer. A non-working link, the website going slow, hanging or worse, crashing, online payment failures, can turn most customers away from e-commerce portals. But beyond the basic rules, how does one ensure the customer finds the right product for himself with minimum clicks?

How does one ensure finding the maximum about a customer asking the least upfront from the customer herself? How does one personalize the entire customer experience? Imagine visiting a website to find the exact product of your choice in the very first scroll. Simple things like knowing the customer's location, likes, interests and friends can be used as a powerful mechanism to customize the website with products targeted for each individual user. When it comes to this sort of personalized customer experience, Amazon is known to be the master of the craft. With every click, Amazon's website keeps learning about the user and rendering more customised results.

No wonder, it is a clear market leader when it comes to personalized user experience. Almost 30%-40% of searches are now taking place on the mobile phone. Indian mobile-commerce is expected to grow at 70% CAGR between 2012-16. An estimated 11% of India's e-commerce business is now taking place through mobile phones. Customers are growing device agnostic.

With the rapid growth of mobile and smart phone usage, those who have first mover advantage and can capture the users through a good mobile website and mobile application experience would likely win the race. The challenges and trade-offs though will be in terms of investment of time and resources.

Once the purchase is completed, the next point of the supply chain is delivery of the product to the customer. What if the product the customer orders is found to have gone out of stock? What if the delivery takes a long time and requires multiple follow ups with the call-center or support teams? These are practical issues which most e-commerce portals are facing today. How much and what to stock, large variety of SKUs, maintaining real time inventory on the websites, how to ensure the customer gets what he pays for? What if the customer ordered one product and received another? What if the product delivered is defective?

> "The key is to ensure the supply chain is set up and maintained top-notch at both input and delivery side."

What if the customer books a hotel room online and the photos shown on the website are very different from what the rooms actually are? How do you ensure quality of service delivered does not suffer? The key is to ensure the supply chain is set up and maintained top-notch at both input and delivery side, not just in terms of speed of delivery but also quality of products. I personally have been delighted by the four hour delivery time promised and adhered to by a certain apparel website. Since then, I have switched to buying most of my apparel from this wonderful e-commerce portal for clothes.

What if the customer booked a flight with a particular online travel site and the flight was delayed? Would the customer hold the online travel agency or the airline responsible? How responsive is the company to not just acknowledge a problem but to take its ownership to get the issue resolved? Some of these issues are under the

5 point formula to grow without discounting

1. Variety of product offerings
2. Best in class web experience
3. Efficient supply chain logistics
4. Customer centric call centre teams
5. Effective mobile platforms

e-commerce company's control and some are not.

While it is important to minimize the customers' problems, it is equally important to have a standard set for responding to customer complaints. How the lowest level resource - the call centre agent responds to a customer complaint is what will determine if the customer is likely to return to make a purchase.

On one hand, there are companies who have 'no-questions-asked' return policies; on the other there are companies which make the customer run for her money, even when their own product was defective or the customer had an unpleasant shopping experience. Over the long term, e-commerce firms that ensure customer delight are likely to sustain, even when they start commanding a higher price for their services.

The e-commerce portals also need to have a strong feedback loop set up with their product suppliers to ensure customer delight. At the end of the day, the fact remains that if a customer has purchased a product through an e-commerce portal and is dissatisfied, then ensuring return and refund or exchange is the portal's responsibility. Whosoever takes full responsibility and for ensuring customer delight at all levels of service can become the market leader when it comes to online customer loyalty.

With all these ways of service differentiation, clearly discounting is not the only way to build customer loyalty. In fact, it is possibly the worst. Discounting only induces trial. The rest depends on what the user experience is. Even while selling a commodity like a computer accessory, all the above factors can take a particular e-commerce company way ahead in the race. Competing on service differentiation is in the e-commerce company's hands and can make all the difference even in a commoditised product market.

Written by:
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PGPEX 2013

QUICK FACTS: FIVE GREAT WAYS TO MAKE USE OF THE INVESTOR'S MONEY.

1. **Technology** – Nothing beats a great seamless, personalized online shopping experience
2. **Innovation & First Mover Advantage** – Can you be the first to offer something to the customer?
3. **Logistics** – Which customer does not love same day delivery?
4. **Acquisitions** – Myntra + Flipkart = The Future?
5. **Talent** – Great people build lasting companies!

THE ECONOMICS OF **TECHNICAL DEBT**

What is technical debt? Consider that in a business organization the IT department is rushing to meet the deadline for development of an important software application. The software programmers in the IT department still have major components to develop as the deadline approaches. In such a situation, either of two things can occur:

A) The software programmer makes a conscious decision to compromise with the architecture of the application so as to deliver it by the due date. He develops a long, convoluted logic code which does not follow the design standards laid out for the project. As a result both the code quality and application architecture are compromised.

B) The software programmer was unaware of the design standards or conventions for the project and he unintentionally developed code that degraded the quality of the software code.

> The degradation of the design, quality of code and architecture of the software is known as the **technical debt**

In both cases, although the development of the software application may have met the deadline and it functions correctly, the software code quality and its design standards have been compromised. This degradation of the design, quality of code and architecture of the software is known as the technical debt of that software application. This has important consequences for the future. Another programmer working on the same software application to develop a new business application or to make modifications to the existing one will have to spend more time to understand those parts of the logic of the software application whose quality had been compromised.

The additional effort, resources, time and money spent later to locate and amend the code and design to meet the expected quality standards or to remove any architectural shortcuts made earlier due to shortage of time gives the **measure of the size of technical debt.**

As per a study conducted by CAST, there is an average technical debt of $3.61 per Line of Code (LOC)[3]. According to Gartner, the current global IT debt stands at $500 Billion, which is, expected to double to $1 Trillion dollars by 2015[7].

Technical Debt is often compared to financial debt; it has characteristics of principal and interest like financial debt, except that technical debt does not have any precise unit of measurement unit [9]. However, today with improved IT processes and tools, technical debt can be measured either in terms of Kilo Lines of Codes (KLOC) of the software application or in terms of Total Quality Index (TQI): a composite score of robustness, performance, scalability, transferability and changeability [3] that can be associated with monetary value[13].

Just as in financial debt, technical debt gets compounded over time. If we do not make good the debt by putting in effort to improve the software design and architectural standards, the debt will increase on a compounded basis with each successive software application release cycle, further worsening the quality of the software application [9].

Business management often argues that the purpose of information technology is to support its core business functions. Any investment in improving the quality of the code does not justify opportunity cost in terms of additional time and resources expended. While this may be true in some cases, especially if the developed software has no further application, mostly as technical debt keeps compounding, a stage may arise when the later versions of the application fail to be changeable (ability to make changes quickly) and transferable (ability of other team members or other teams to understand the existing logic) [9], which will lead to a substantial IT budget expenditure on maintenance rather than new development of the software application.

ECONOMICS BEHIND TECHNICAL DEBT

Measuring technical debt helps us to understand when it is best to engage in mitigation of the technical debt and maximize the total economic value from the software application. New IT processes and tools make it possible for us to measure the quantum of technical debt.

A software application can be considered as a production function of a number of function points (unit of measurement to measure the amount of business functionality present in a software application) of an application and the length of the code (measured in terms of KLOC) written to develop the application.The output of this function is the quantitative measurement of quality of the software application represented as total product index.

Total product index = fx (Software code (KLOC), Number of function points) - Equation 1

Table below shows the number of function points and the number of lines of code written to develop those function points. The total product index is the production function of the two input variables with the variable function points kept constant.

MEASURING **TECHNICAL DEBT**

Function Points	KLOC	Total Product Index	Average Product Index	Marginal Product
30	0	0	0.00	-
30	15	450	30.00	30.00
30	16	500	31.25	50.00
30	17	545	32.06	45.00
30	18	575	31.94	30.00
30	19	600	31.58	25.00
30	20	620	31.00	20.00
30	21	630	30.00	10.00
30	22	635	28.86	5.00
30	24	635	26.46	0.00
30	25	620	24.80	-15.00
30	26	600	23.08	-20.00
30	27	575	21.30	-25.00

Table 1

TOTAL PRODUCT INDEX

It represents the application's **structural quality aspects** such as: software design standards, robustness of architecture, application scalability, security implementation etc. and the application's functional intricacies such as complexity of functionality, maturity and future usage of the application. **The index gives us a measurement of the quality of the software application.** Both these qualities have some degree of correlation with the number of function points and software code. The structural quality of the application decreases as KLOC of software code written for a given number of function points increases. While, the functional intricacy of the application generally increases with the increase in the number of function points.

The impact of technical debt on a software application can be understood through the economic analysis of the production function *(Equation-1)*. Here, we consider

that the number of function points in the production function is constant for a given software application to be delivered. If no measures are taken to reduce the technical debt, then the software application code in terms of KLOC that has to be written to deliver the next software release will increase with each successive release due to increasing complexity and technical challenges. The *law of diminishing marginal returns* will govern the output of every successive software application.

MARGINAL PRODUCT

It is the marginal increase in the total product index compared to previous release for every 1 unit increase in KLOC written to implement it. As, with each successive release, the number of lines of code required to implement function points increase, the total product index of the application gradually decreases as a result, and the marginal product declines in stage B and stage C, after an initial increase in stage A.

$$Marginal\ Product\ =\ \frac{\Delta\ Total\ Product\ Index}{\Delta\ Software\ Application\ Code}$$

AVERAGE PRODUCT

It is the total product index of software application compared to the lines of code, KLOC written to implement the same.

$$Average\ Product\ =\ \frac{Total\ Product\ Index}{Software\ Application\ Code}$$

Figure-1 depicts the law of diminishing marginal returns for a software application that has gradually acquired technical debt with successive release cycles.

The total IT budget for a software release cycle can be represented as: -

$$Total\ IT\ Cost\ Budget\ =\ \frac{Fixed\ Cost\ (Maintenance\ Cost)}{Variable\ Cost\ (Function\ Points)}$$
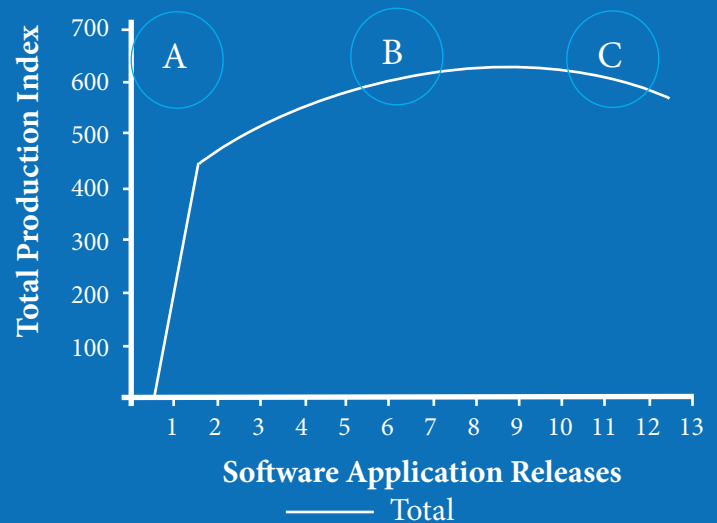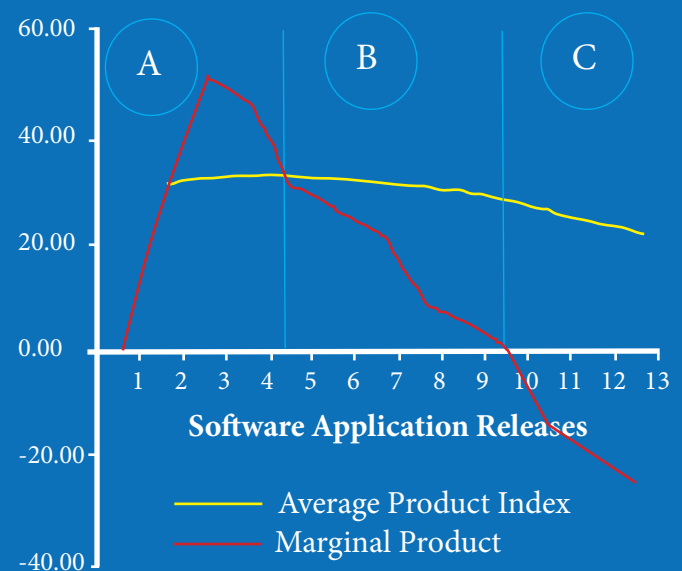

Figure 1

Figure 2

If each function point is assumed to be of the same complexity, the cost of development of each function point will be same, as a result the total variable cost for development of the software release will be constant. However, the fixed maintenance cost will increase with each successive release cycle, due to the increase of issues attributed to the poor design or architectural flaws.

Figure-2 is divided into three stages, each representing a different phase of software application.

STAGE A

When an IT investment is made by a business organization; the goal is to implement core business functionalities that would support business processes. During the initial phase, IT budgets are allocated for development of the software application. The application may have a relatively clean design without many architectural decisions to be considered.

New functional features are continuously added to the application without much emphasis on degradation of the design standards or the architectural constraints. Software application is still in scalability mode. As shown in *Figure-1*, the total product index of the application that comprises of the structural quality and the functional intricacy increases. Although the structural quality of the application decreases with each subsequent application release during this stage, overall product index increases because of increase in the functional quality. As shown in *Figure-2*, the marginal product of the software application is greater than the average product index of the application in stage A. Therefore it is more beneficial for the business organization to implement business requirements without allocating significant budget towards initiatives in resolving technical debt.

STAGE B

A software application is considered to be in this stage once it has functionally matured. An application in a matured state is characterized by intricate workflows and complex business implementations. New functionality implementation decreases considerably and majority of the application development is for modifications or refinement of the features in the application. During this stage, IT expenditure towards the maintenance of the application grows significantly. If the firm's management does not act towards resolving the technical debt, it will have to incur much higher costs later owing to compounding of the debt. The incremental change in the total product index increases but at slower rate than in the previous stage.

In this stage, as shown in *Figure-2*, the marginal increase in the product index is less than the average product index of the software application. As a result the total product index increases at slower rate than in the previous stage, as shown in figure-1. Unlike stage A, where the management can stay focused on scalability of the application, the management should begin to think of the future of the software application in stage B (please refer to 7 Key Decisions: Measure, Monitor and Mitigate Technical Debt in this article). If the management fails to recognize the importance of strategic decisions towards mitigating the technical debt in this stage, the technical debt can lead to further deterioration of the software application and will have to be separately dealt with in Stage C.

STAGE C

This is the terminal stage for the development of the software application. An application is categorized in this stage when it has accumulated a large amount of technical debt. As shown in *Figure-1* the total product index of the application declines because of the marginal decrease in the total product index. Due to a large amount of technical debt, the structural quality of the application declines to such an extent that it outweighs the functional quality of the application. In this stage the average product index of the application decreases due to impact of negative marginal product index. This implies any further changes to the application will cause more issues. A significant IT budget goes towards maintenance of the application rather than development of any new functional features. The effort required for clearing the technical debt of an application is estimated to be greater than the total value that can be achieved from it. Under such circumstances, the firm's management may have to decide to scrap the old application and invest in building a new application instead of fixing the problems with the existing application. This may be because the application has reached such a critical point that any further enhancement or addition of new features to the application requires changes to the existing design implementation or architecture that is no longer cost effective. This situation may also arise because

of obsolescence of the technology platform, or of open source alternatives available in the market, or unavailability of technical resources. Here, a decision to scrap the existing application and build a new application is often considered more feasible. The decision also depends upon the criticality and complexity of the application. For complex business applications that are critical to the core business processes of the organization, it may be more viable to invest in reducing the technical debt of the existing application. It is thus increasingly important for the firm to understand the significance of the technical debt, and how timely action towards planning of mitigation of technical debt can prevent a software application from reaching stage C. The goal here would be to increase the useful life of the software application.

SEVEN KEY DECISIONS MEASURE, MONITOR AND MITIGATE TECHNICAL DEBT

Initiatives such as technical debt mitigation not only involve the IT department, but also require significant attention at the C-suite level; the CIO of the firm should take this responsibility. The CIO should invest time on 7 key decisions before creating a strategy for technical debt mitigation.

1. IDENTIFY THE STAGE
2. ACCESS THE USEFUL LIFE
3. IDENTIFY THE CRITICAL BUSINESS COMPONENTS
4. ESTIMATE TECHNICAL DEBT
5. BUY-IN FROM CEO
6. RE-ESTIMATE DEVELOPMENT EFFORT
7. LONG TERM STRATEGY

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