Mitigating strategies to address Non–Technical losses and Infrastructure damage within electrical supply networks

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Abstract — Electricity theft, Cable theft and Infrastructure damage are defined as the leading causes to system non-technical losses. These losses cost the South African economy anything up to R20 billion rand annually. Historical strategies deployed using generic security applications to combat the problem has not yielded any real economical value to date and in fact contributes to the overall economical losses suffered within the South Africa context. Proactive strategies need to be employed with the focus on deploying specialized technologies as the first point of departure and the strategy further needs to adapt an integrated approach in mitigating the problem.

Keywords — Cable Theft, Infrastructure damage, Non-Technical losses, Mitigating Strategy, Return on Investment.

I. INTRODUCTION

Non-Technical losses are defined as losses which are attributed to external factors such as cable theft, illegal connections and infrastructure damage. This is a pervasive problem that does not just affect the economy of South Africa but more importantly presents a real-life hazard to communities living within these conditions [1].

It is recorded by Eskom that these losses account for anything up to R20 billion rand a year, of which Eskom suffers average losses of approximately R5 billion per year. The remainder approximate R15 billion is attributed to municipality losses because of this phenomenon. [1].

Municipalities which act as an intermediary between Eskom and the end user are highly dependable on the revenue generated from electrical sales and this account, in most municipalities, to be on average 40% of the total revenue collected [2]. On the other hand, Transnet and Telkom which do not supply electricity but use copper cable or conductor in their daily execution of their business activities, suffers the same fate and as a result further compounds the problem within the South African economy. With the introduction of renewable energies, the likelihood of revenue diminishing under these conditions is bound to occur and the management of infrastructure has thus now become a real concern and cause for proactive action to be taken

The intended outcome of this paper is to present current strategies deployed, highlight the economic effects it has, and thus suggest a different strategy to mitigate and arrest the problem as a way forward.

II. BACKGROUND

The demands for base metals such as copper, aluminium and lead are driven by market world demand requirements. Figure 1 represents the generic demand value chain found within the South African context.

Criminal activities which contribute to the theft segment of the value chain are attributed to two factors, namely:

- Socio economic conditions, and
- Crime syndicate operations

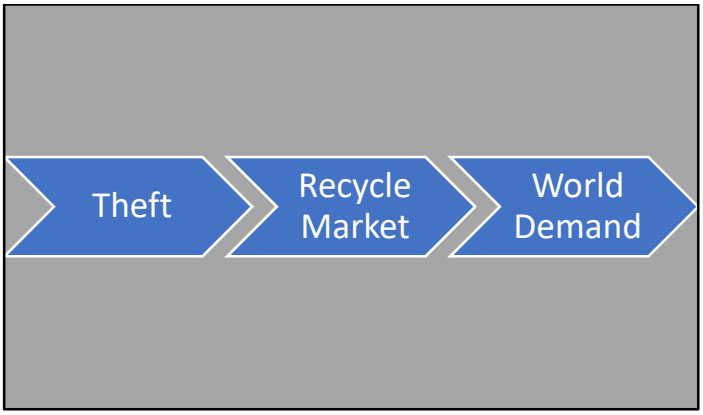

Figure 1 – Value chain for copper demand

Without a sense of world demand, it could safely be assumed that the manifestation of the problem would not be as pervasive as currently reported, however the demand is ever increasing and is bound to get worse with the development and manufacturing of the new technologies such as the electrical vehicle, Internet of Things (IoT) for example.

Figure 2 [3], illustrates the copper production in millions per ton related to mine production capacity. It is worth noting that the increase from 1980 to 2015 production requirement almost doubled. It should further be noted that the anticipated peak of production is estimated to summit in 2030, thus highlighting the anticipated demand for the next 10 years.

This increasing market demand is noteworthy, as it illustrates that if mines cannot produce the required demand, the variance in demand would be satisfied by the recycling market.

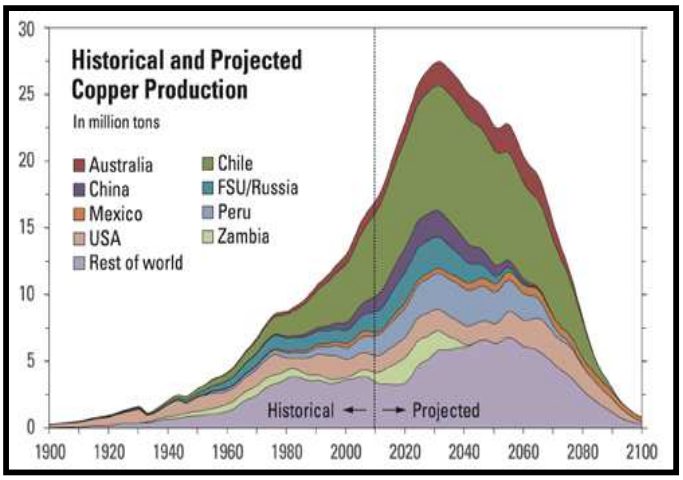

Figure 2 – Historical and Projected Copper production [3]

Figure 3 [4], represents the demand versus supply of copper for February 2017. From this figure there is a clear indication of demand outweighing supply (2017-2020), and the consequential effect it has on the copper price should be noted. The assumption is then made that the creation of a market environment for the recycling industry is then perpetuated. From this figure 3 the London Metal Exchange (LME) copper price increase clearly indicates the lucrative conditions created for the recycling market.

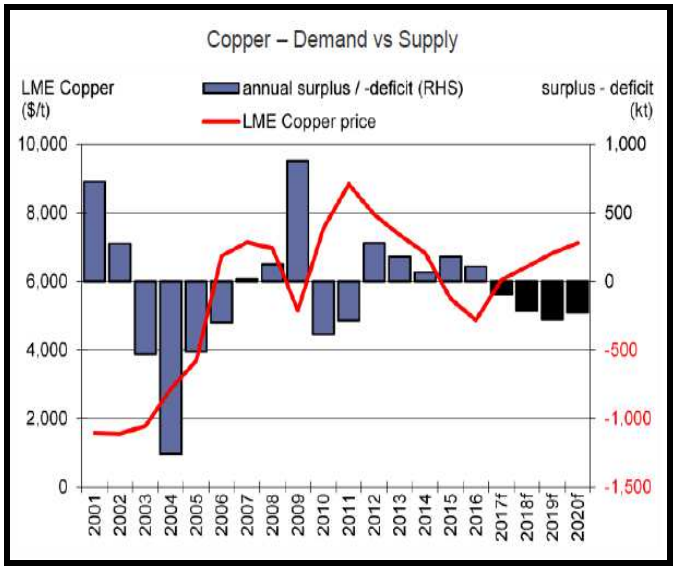

Figure 3 – Copper Demand vs Supply

Morgan Stanley, a commodity research company highlights the anticipated world copper demand requirement as indicated in figure 4 [5], and isolates China as the largest commodity user, this been for historically trends as well as for futuristic projections.

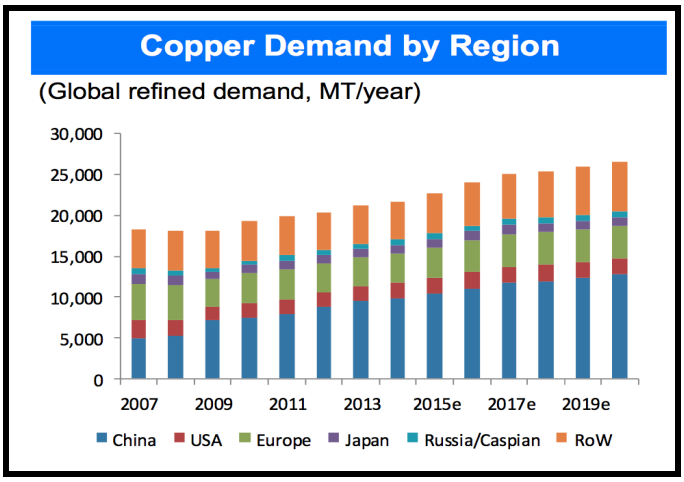

Figure 4 – World demand of Copper

As previously alluded to the supply of base metals are driven by market demand and as shown figure 5 [6], the anticipated demand for copper in 2022 for China will be 48% of the total world demand, thus highlighting its appetite for copper even further as compared to previous years.

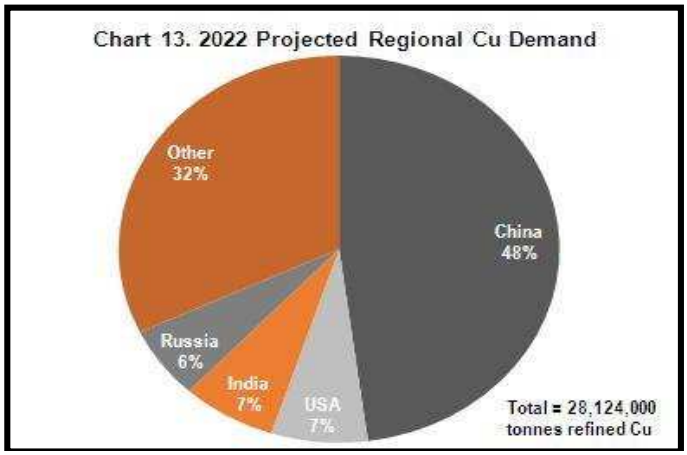

Figure 5 –Projected copper demand for 2022

III. MITIGATING STRATEGY

An online publication [7], *"SA now leading exporter of (cable) copper"* highlights that copper theft in Transnet for 2008-2009 equated to 6917 recorded incidents with an estimated replacement cost of R239m and in 2010-2011. Eskom recorded the estimated replacement cost at R265m further highlighting that the indirect cost to the economy of R5bn, which is inclusive of the *"cost of replacement and security; the shutdown of business operations; loss of income; loss of exports; power, communication and transport outages; and negative investor perceptions"*. The publication further highlights that a total of 72533 incidents were reported to the South African police services during the previous year and that 10736 arrests were made during this time. This article fails to present the successful conviction rates associated with these arrests but highlights the fact that only 15% of the incidents recorded translated to arrests.

Furthermore, in the official publication of the *"The Association of Municipal Electricity Utilities of South Africa (AMEU)"* for March 2018 [8], presents statistics offered by a service provider operating within the forensic and investigative sphere. This company specifically deals with cable theft and infrastructure damage within state owned enterprises such as Eskom, Telkom, Transnet and various other municipalities within South Africa. The article highlights that an average of 85 arrests are made per month within its customer base and presents a conviction rate of 90%. The article further highlights the deployment of a sophisticated helicopter as part of their operational strategies to combat cable theft and infrastructure damage.

Eskom alone recorded in their annual financial statements for 2016-2017 [9], that the non-technical losses associated with electricity theft and infrastructure damage cost the utility R1.2bn in 2016 and a further R1.3bn in 2017. The notes to the financials further indicate that losses of R70m was recorded for 2017 compared to R85m in the previous year due to cable theft and other related equipment. Associated with this are the arrests made reflecting a total of 235 compared to 229 as per the previous year in 2016 reflecting an increase of 6 arrests. The value recovered for both 2016 and 2017 reflects an amount of R5m year on year. This clearly illustrates that current initiatives are challenging and that these initiatives although commendable are still far from reaching the desired outcome in comparison to the total losses suffered by the economy.

The current strategy deployed by the state-owned enterprises is highlighted in figure 6, where most of their budgets are spent on forensic investigating task teams or generic static security services to address the problem, this with a limited amount of budget spent on technologies specifically designed to address the problem. From experience this limited budget relates to budget expenditure of not more than 15% of the overall security strategy budget, and within this 15% more assets are protected over a larger geographical area where the generic and investigative services are task orientated to a specific incident or area.

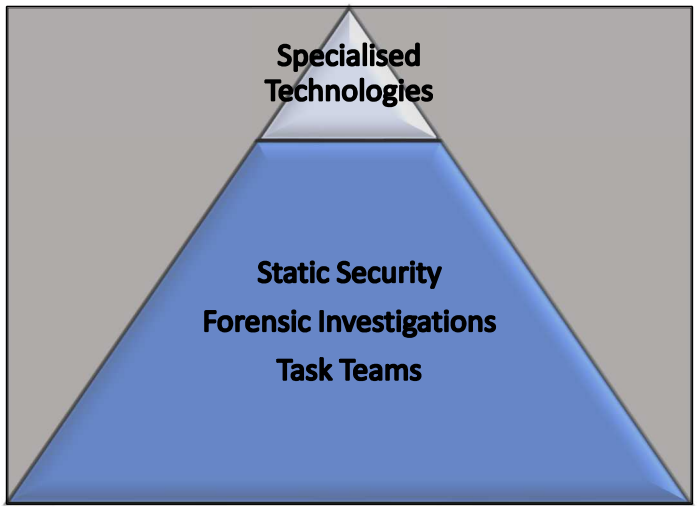

Figure 6 – Current budget strategy deployed by SOE's

A question one might ask is to how this strategy is problematic?

The presupposed value addition of the investigate initiatives that are implemented, are designed to address the criminal activity within the recycling markets, thus addressing the market where the stolen goods are being offset for reward. Although various prosecutions have been successful, historically these initiatives have shown limited results in comparison to the desired outcome of reducing the problem as initially anticipated, and so the unscrupulous element within the recycling market continues to be problematic. It is worth noting that in the mitigation of these recycling markets these investigations usually occur after the fact, which still leaves the customers exposed to the economical and reputational losses.

To further address the question, the answer should lay within the return on investment expectations.

Using the data provided earlier the average cost per incident can be calculated as follows:

Case 1 – Transnet incident cost (2008-2009)

Actual replacement cost = R239m
Actual Recorded incidents = 6917

Cost per incident = R239m/6917
≈ R 51 000 per incident

Case 2 – Average actual cost to the economy (2010-2011)

Actual cost to the economy = R5bn
Actual Incidents reported = 72533 (2010)

Cost per incident = R5bn/72533
≈ R 70 000.00 per incident

Based on the calculated information, the rationale is made that the cost per incident can be quantified as anything more than R50k per incident.

Other entities have recorded higher loss per incident values and these will be highlighted in presentation of the Ethekwini Metropolitan Municipality case study.

Let's consider the actual loss suffered based on 85 arrests per month as previously referred to, to highlight the cost per incident to the economy.

85 arrests @ R70K = R5.95M loss per month (R71.4m p/year)

It should be noted that the above is not considered as a saving as the incident and damage has already occurred and losses suffered to the entity and should also be noted that this initiative only addresses 1.4% of the total loss of R5bn per year.

Form this more needs to be done to protect the assets rather than just focus on arrests, as the proliferated damage to the economy continues to occur.

With this analogy presented, the justifications of the budgetary spending patterns are not sustainable and present very little return on investment. The contracts that are currently employed under these generic security strategies run more than R150m a year within the various entities, and the impact these contracts make are questionable, as the measured rate of successes are attributed to the number of arrests, the associated conviction rates and the recovery of the stolen items. Although these initiatives provide for some relief the problem, the problem is not diminishing but in fact increasing.

The key strategy that should be deployed; is by firstly deterring the incident from occurring failing which detecting the incident and dispatching specialised task teams to the specific point of incident as quick as possible. This strategy lends itself to a significant reduction in losses.

How is this done? A strategy should be adopted around the deployment of specialised technologies designed to mitigate the problem and should be the first point of departure in the strategy in terms of budget expenditure. The complete solution offered should be a ***"separated integrated approach"*** as per figure 7, meaning that the complete service model in the strategy should be services offered by individual service providers for technologies, response and investigation to address the problem collectively.

This strategy will allow for the following:

- More assets are to be protected *pro-actively* within the total allocated security budget.
- Rapid *re-active* response to the point of incident.
- Accountability by the service provider for its respective contractual tasks and obligations.
- Audit trail processes of the complete strategy value chain.

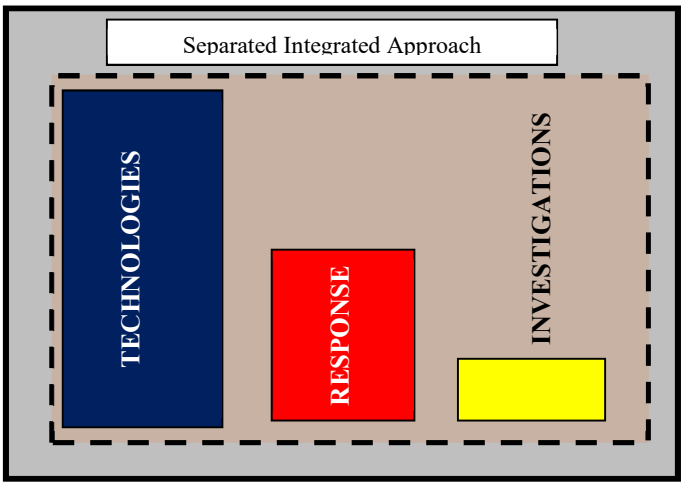

Figure 7 – Proposed Strategy of implementation

Figure 8 highlights to proposed value chain of the ***"Separated Integrated Approach".***

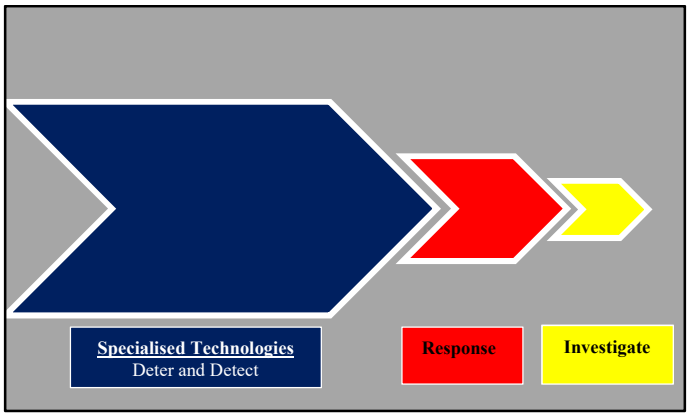

Figure 8: Proposed strategy value chain

It is further suggested that the various specialised technologies deployed should be rented under a service level agreement with all the associated services of control room management and maintenance as indicated in figure 9.

This then allows for the following:

- Continuous development of new technologies based on lessons learnt.
- System upgrades during contract periods, free of charge
- Guaranteed continuous system operation and up-time.
- Continuous maintenance and audits.
- System fault management.
- Accountability by the supplier
- Penalty enforcements by the customer.
- A wider range of assets are protected
- Budgetary compliance in terms of the various public and municipal financial management acts.
- Financial accounting benefits
- Not having redundant security products left in-situ.

Figure 9 – Proposed SLA of Technologies deployed

IV. CASE STUDY

In a paper presented to the South African Revenue Protection Association in 2016 [10], entitled *"The economic benefits of using GSM Pepper Gas Alarm systems in electrical distribution substations: An eThekwini Municipality Case Study"*, the economic benefits presented have been summarised and presented hereunder.

Total number of systems deployed	: 160 units
Contract duration	: 3 years
Ave Cost per incident (as per Ethekwini)	: R240k
Incidents per site prior to deployment	: 2
Total number of incidents per year in subs	: 320

The losses Ethekwini Metropolitan Municipality suffered prior to the deployment of the technologies were:

320 incidents @ R240k = R76.8m

Post the deployment of technologies **NO RESPONSE AND INVESTIGATION was included for** due to budget constraints within the municipality.

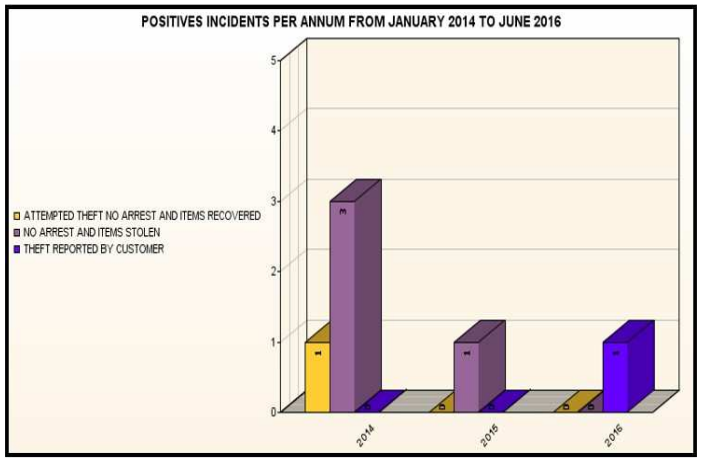

Figure 10 – Positive incidents recorded for 2014-2016

It is noted from figure 10, that only 6 positive incidents where recorded during the 3-year period of system deployment within the 160 sub-stations. This mitigating strategy deployed in Ethekwini allowed for the following economic indicators to be presented for the 3-year cycle.

Prior to deployment loss	**: R76.8m**
Post 3-year deployment loss	**: R 1.4m (6 @ R240k)**
Contract value over 3 years	**: R 10m (over 3 years)**
NET SAVING TO ENTITY	**: R 65.4m**
Loss Reduction ratio	**: 98.1%**
Return on investment ratio	**: 85.16%**

From this case study presented it is very clear that technologies on their own play a significant part in the mitigation of the problem and proves that it should be the first point of departure in the overall integrated strategy as this allows for less capital to be deployed to affect a higher loss reduction ratio and ultimately effect a higher rate of return on investment.

V. CONCLUSION

Cable theft and infrastructure damage is a pervasive problem in the South African economy and it is here to stay if the market demand requirements are not satisfied by the production of base metal mining. Although strategies have historically been deployed to address the recycling market criminal activities, not enough is been done to address the complete problem. The presence of current strategies must be revisited, and new strategies must be adopted to address the problem holistically.

Such a new suggested strategy should the deployment of specialised technologies designed around combating the problem as the first point of departure, and thereafter allow for the associated services such as response and investigation to be integrated into the mix.

This will allow for a richer return on investment and more prudent financial management and accountability within the allocated budget and expenditure plan.

ACKNOWLEDGEMENT

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