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Innovation through process automation: Factors for success

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Full-Research paper

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Abstract

This paper seeks to identify critical success factors and inhibitors in process improvement initiatives such as process automation and application integration. In a fast-paced global competitive environment, business processes are considered a vital organizational asset and key differentiator. Several business process methodologies were considered to understand the efficacy of process improvements to accomplish desired benefits. A hybrid research methodology is used to deep dive into these factors combined with a pragmatic analysis of the phenomenology of a study abroad application process of an Australian University, after enabling automation and application integration. Additionally, a supplementary analysis of case studies is presented to deduce how process improvement frameworks influence or inhibit process improvement initiatives. Factors in a business process management (BPM) capability framework were mapped to identify critical success factors (CSFs) and inhibitors. The outcome of this research is a theoretical framework to support organizations to successfully implement continuous improvement initiatives.

Keywords process automation, business process management, critical success factors, process improvement, six sigma

1 Introduction

Change is inevitable. The rapid evolution of technology requires dynamic approaches (Binci *et al*., 2019), innovation and strategy in economic, political, and social landscapes to continuously evolve to future fit organizations digitally (Syed et al., 2018), while technological advancements vastly impact the business processes of organizations (Mendling *et al*., 2018). Process improvements are recognized as being influential in most organizational change and transformation initiatives (Bandara *et al*., 2019), however, studies show 85% of projects fail during execution which can be damaging to organizations (Heeks, 2003). Consequently, garnering the perspectives of project impacts on various business units is imperative to leveraging technology (Leong et al., 2020) while improving project delivery success rates. Higher education institutions are no exception to such changes (Rosemann, 2017). Graduate outcomes are not promising according to census results, as male bachelor's degree holders a decade ago, earned more than 2018 graduates aged 25-34. Additionally Australian Commonwealth government tuition subsidies dropped in 2017 for the first time since 2003, while Commonwealth research grants plunged over 30% (Norton and Cherastiddtham, 2018). Evolving legislative change to the economic model of Australian higher education (Rosemann, 2017), coupled with fast-paced technology challenges, altered how university treated productivity in operations and service delivery. All aforementioned factors provide good reasons for driving innovation and knowledge creation, which can better be embedded in business processes ((PwC), 2016). Given these diverse results, the objective of this research is to grasp if initiatives employed lead to success or failure? In addition, the research question posited asks if there is a theoretical framework that can be adapted to increase the success rate of process improvement implementation to better guide organizations.

There are numerous process improvement frameworks that can be utilized to manage business processes (Bachiller *et al*. 2022). Some of these frameworks are business process re-engineering (BPR) (Hammer et al., 1993), business process management (BPM) (van der Aalst 2004), six sigma (Pyzdek, 2003), total quality management (TQM) (Montgomery and Woodall 2008), and the more recent navigate – expand - strengthen – tune and take-off (NESTT) methodology (Rosemann 2017). Thus, it is imperative to have an effective strategic approach to ensure successful project delivery by understanding business processes - even government bodies encourage the inclusion of business process competency in higher education to be embedded in employability skills (Lightfoot 1999). We will now briefly examine some of the frameworks used in business process automation, commencing with business process management.

2 Process Redesign Frameworks

2.1 Business Process Management

Business process management (BPM) adoption is rapidly increasing (Bandara *et al.,* 2016), BPM is a emerging compelling area of business (Seethamraju, 2010). It is a collection of techniques, methods and tools that supports analysis, design, and management of operational business processes (van der Aalst, 2004). The objective is for better outcomes of process improvement in organizations (Rosenbaum *et al*., 2017). Awareness and perception of BPM techniques is a must to effectively implement innovation and strategy, it is also needed to understand variables relating to change (Binci *et al.,* 2019) to achieve the desired improved performance, productivity, and efficiency (Syed *et al.,* 2018). Despite BPMs increasing adoption in industry and academia, disparities exist between BPM approaches and technologies required by BPM users (van der Aalst *et al.,* 2016).

2.2 Business Process Re-engineering

Reengineering dates from the 1950's and builds through radical change or enterprise-wide process improvement (Feller and Bentley, 2001). To achieve major and dramatic business re-engineering outcomes, it is essential to plan for innovative and revolutionary change in business processes (Murray and Lynn, 1997) where business process reengineering (BPR) had a decade of merits (Feller and Bentley, 2001) as the saviour of organizations. Redesigning inefficient business processes resulted in a 75% staff reduction of the accounts payable process by the Ford Motor Company. In 1995 BPR was adopted across different industries. However, in a study conducted by the Computer Sciences Corporation (CSC) (Alter, 1994), reengineering was the top critical issue for information systems from 1989 to 1994. Approximately 75% of BPR project failure was attributed to reengineering having become passe, with over 600 information systems executives divulging that BPR was no longer the top priority (King, 1995). Reflecting on the successes and failures of BPR and understanding the critical success factors and inhibitors of process improvements, thus becomes imperative.

2.3 Six Sigma

Six sigma as a framework is considered a highly effective, focused, and methodical implementation with verified quality techniques and principles to manage effective process improvements, while eliminating errors. The standard for six sigma is 3.4 defects per million opportunities (Pyzdek, 2003). It is one of the modern business strategies aiming for superior organizational performance in a competitive landscape of process improvements. One of the methodologies used by six sigma is DMAIC (define, measure, analyse, improve and control) (Noori and Latifi, 2018). A successful application by Zhan (2007) is illustrated in a student recruitment process improvement case study, where six sigma effectively used DMAIC. Zhan's (2007) case study in 1987 to 1993 notes organizations utilizing six sigma improved their business performance by 94% (Montgomery and Woodall, 2008).

2.4 Total Quality Management

Total quality management (TQM) is another framework for managing and implementing organization-wide strategic improvement initiatives originally conceptualized in 1980's by the influence of the philosophy of W. Edwards Deming, Joseph Juran and others (Montgomery and Woodall, 2008). It is way of living of continuous improvement to ensure customer satisfaction at lower cost by harnessing everyone's commitment within the organization (Kanji, 1990). TQM is industry agnostic, hence applied across different industries. The car company Jaguar adopted the framework to rehabilitate declining market share through quality and customer service and has recovered with increasing profits and total turnover (Kanji, 1990).

2.5 NESTT

Navigate-Expand-Strengthen-Tune and Take-off (NESTT) is an accelerated process improvement adopting innovative rapid process redesign methodology using spatial affordances (Rosemann 2017). It is considered an exploitative process improvement dedicated to operational effectiveness and efficiency in each value proposition (Rosemann, 2022). NESTT implementation resulted in the improved process performance of idea implementation within a timeframe of 20 days and proposal for 20 months, including positive impact on attitudes towards change and organizational culture, while eliminating 50% administration efforts and streamlining processes (Rosemann, 2017) and has been successful in delivering results. NESTT is an emerging methodology with limited literature, case studies and application. An extensive practical application in different domains is needed to understand its effectiveness. Next let us an examine the real scenario case study for this paper – a study abroad process.

3 Study Abroad Process

The target process improvement is a study abroad application process, being an end-to-end lifecycle management for students aiming to study overseas (Bachiller *et al.*, 2022). Study abroad is a niche domain in higher education and embedded in a student's degree. Some institutions aim to send 100% of their students overseas (Berg *et al.*, 2012). The high-level process starts with an information session, then a study overseas application, assessment, nomination to host university, acceptance of host institution, departure, overseas study, return to the home university and finally application for credit. The process architecture and detailed steps are described in detail in Bachiller *et al.*, (2022). The fundamental key to business process reengineering is placing data closer to processes (Alter, 1994). The scope of this study are students aiming to study overseas for a short-term (2-6 weeks) or one semester (13 weeks) from 2019 until 2022. We also cover the bridging process from the study overseas application until nomination to the host university as illustrated in Figure 1. This sub-process incurs extensive manual operation and is not connected to other applications. The absence of process improvement can result in internal struggle or chaos (Hammer, 2001), including lack of structure of the process.

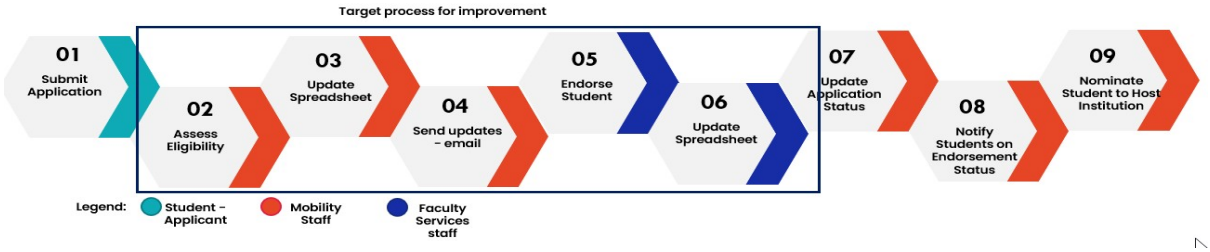

Figure 1: High-level study abroad process before process improvement

4 Methodology

In this research we intend to combine design science research (DSR) (Vaishnavi and Kuechler, 2008), for detailed analysis of process automation and to formulate the critical success and inhibitor model, with qualitative research for the literature review, using the adopted hermeneutic framework (Boell and Cecez-Kecmanovic, 2014), as well as process automation case study analysis indicated in Figure 2.

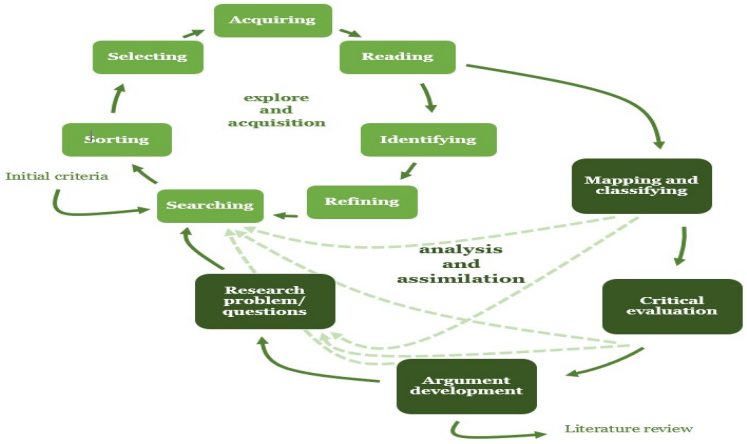

Figure 2: Adopted hermeneutic framework

The DSR will focus on the differences of process efficiency using the six sigma (Pyzdek, 2003) framework before and after process automation and integration, with further analysis to identify critical success factors (CSF) and inhibitors using the BPM capability framework of Bruin and Roseman (2007), focusing both on methods and information technology factors (Figure 3).

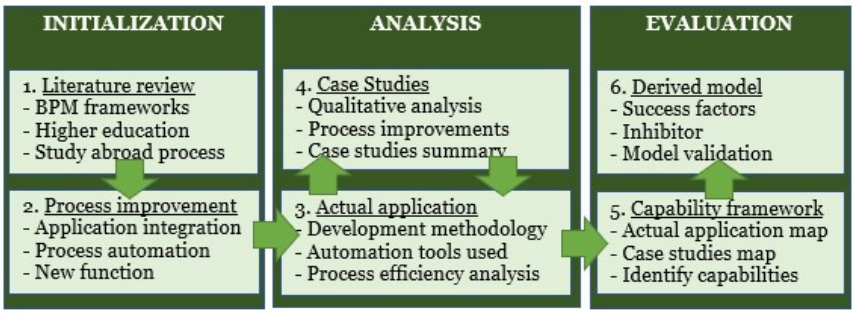

Figure 3: Design science research process

The literature review of process automation case studies will aid in identifying the CSFs for a successful study abroad application process. We will start with examining the 'basket of 8' journals adhering to the search criteria in Table 1. The adopted hermeneutic framework will then be used to identify appropriate case studies. An empirical analysis of the epistemology of these case studies will be aligned to the BPM capability framework, to better comprehend the CSFs and inhibitors.

Criteria	Area	Domain	Automation	Publication Type
Conditions	IS Process Automation	Higher Education	RPA	Case Study
	IS Process Integration	Higher Education	API, ETL Tools	Case Study

Table 1. Literature review search criteria

5 Process Automation

One technology employed to improve the study abroad process is robotic process automation (RPA) using Blue Prism (Ray *et al.*, 2022). RPA is a pre-configured software instance (Wewerka and Reichert, 2021), with defined business rules, including predefined activity choreography to perform autonomous execution of a combination of activities, processes, tasks, or transactions in a single or multiple software applications to complete a service with human exception management (Hofmann *et al.*, 2019). With RPA, repetitive and tedious tasks requiring minimal effort are automated (ForresterResearch, 2014),

including tactical task automation of different business functions. Approximately 31% of revenue growth totalling $2.4 billion in 2021, made RPA a highly successful technology (Ray *et al.*, 2022). The development of RPA through robot or bots typically requires 3-4 months, depending on the complexity of the workflow requiring automation.

In a study abroad process case, different university stakeholders evaluate the student application. Owners of the application process can be the study abroad team, while faculty services and in some cases academics, can perform eligibility assessment if the student satisfies the set criteria to study overseas. Before integration, there are two separate applications, so an independent spreadsheet is updated manually to share progress - causing additional workload on staff. To address this issue, the two applications were integrated through data workflow orchestration in an on-premises extract, transform, load (ETL) tool (Dhanda and Sharma, 2016). A job scheduler was also configured so that the ETL tool could execute on the agreed time. The ETL tool is used instead of an application programming interface (API) because of certain limitations in the study abroad application capabilities. Finally, a new function is provided so that students will be able to upload an academic transcript, apply for credit and access the precedent database. Prior to implementing the new function, the process was performed through email, a disparate process without tracking of student requests, causing tracking issues to students and staff. Provision of a credit precedent database tracking previously approved subjects from universities of previous overseas experience, makes for a consistent and expedited assessment of an academic credit application. Details of our results and discussion now follow.

6 Results and Discussion

6.1 Streamlining the Process

In a study abroad process shown (Figure 1), the target process to be automated is “assess eligibility” process #02. Manual eligibility assessment per application takes an estimate of 2.5 minutes per application, annually applications received are 6900, meaning 287.5 staff hours are spent on this process. Even if a student withdraws before going overseas, assessments must be undertaken, making RPA a pragmatic solution to streamline the process and improve the student experience. The agile methodology (Cockburn, 2007) was used to develop RPA or bots. A walkthrough of the future state was mapped onto how it is manually executed. RPA can only mimic manual operation of the process, has visual perception, can generate reports and perform tasks without interdependency, but cannot perform complexities such as decision making for conditions on choosing the right degree for students enrolled in more than one degree. A workaround was designed to track exceptions and verify the decision if it cannot be covered in a rule-based workflow. Several iterations were undertaken to ensure all possible scenarios were covered. An extract of the RPA algorithm is shown in Figure 4. Due to confidentiality and privacy, some sections were redacted. There is almost no human intervention in the process after the roll out of RPA. Reports are automatically sent to respective staff to validate results.

Another pain point identified in the process was the use of spreadsheet to manage the eligibility of students and collaborate the assessment status with other business units. To improve the process, the two applications were integrated through ETL. The developers worked through requirements as backlogs using the Jira (Funk, 2022) application. The requirements for application integration and additional functions were identified by mapping the high-level process of the future state and the confirmation of scope. This initiative has a larger scope and more stakeholders are involved, making it more complex. A steering committee is established for governance where senior stakeholders decide. Some of the challenges at the early stage were onboarding the correct team, knowledge management, coordination of subject matter experts, project leadership and setting the right direction. After implementation, the target process swas reduced from four to two processes, decommissioning the spreadsheet used and integrating two applications, as illustrated in Figure 5.

The two additional processes #10 and #11 were developed to improve the student experience when applying for academic credit and submission of a transcript of records from the host institution, upon completion of studying abroad. The motivation of the development of these new functions are surging student complaints and lack of tracking of approved units of study using a precedent database to retain historical data from past study abroad students. Given these additional functions to upload academic approval, transcripts of records and accessible approved units of study, a better better relationship to business units and timely reply to students is fostered. The summary of the study abroad process improvements and estimated reduced workload hours in every application, is shown in Table 2 with a high-level description of process improvement, confirmation if the process was improved, assessment of activity value, reduced hours after implementation and cycle time before and after process

improvement. The data is from the subject matter expert, while the cycle time is based on event logs (van der Aalst, 2004) of the study abroad application.

1. Launch and login to [redacted].
2. Navigate to the list of student applications in [redacted] Mobility Database query
   i. "04_BOT_Query_EligibilityAssessment_Exchange"
3. Extract the list of student details into a spreadsheet
4. Launch and log into [redacted] web
5. Navigate to Manage students
6. Click on internal transcript
7. For every Student in the list,
   a. Fill in the student ID # then click 'continue'
   b. Perform below eligibility checks based on previous section with **Enrolment Status:** [redacted]
      i. **Weighted Average Marks** (WAM) should be greater or equal than [redacted]
      ii. **Progression Status** should be [redacted].
      **Other variations may show and you can refer to Table 1 highlighted in yellow for other cases*
      iii. **Successfully completed Credit Points** is [redacted]
8. If the student passes all the above conditions, then they are considered eligible. add the tag "BOT_ST_AAR_ReviewEXC_Processed" and "BOT_ST_AAREXC_ Eligible"

If any of above check fails, student is not eligible for academic credit assessment add the tag
"BOT_ST_AAR_ReviewEXC_Processed" and ("BOT_ST_AAR_ReviewEXC_Unsuccessful" (Do not have WAM) OR
"BOT_ST_AAR_ReviewEXC_Not Eligible_Below WAM" OR
"BOT_ST_AAR_ReviewEXC_NotEligible_NotMeetProgression" OR
"BOT_ST_AAR_ReviewEXC_NotEligible_NotMeetCP"

Figure 4: Extract of RPA Blue Prism algorithm

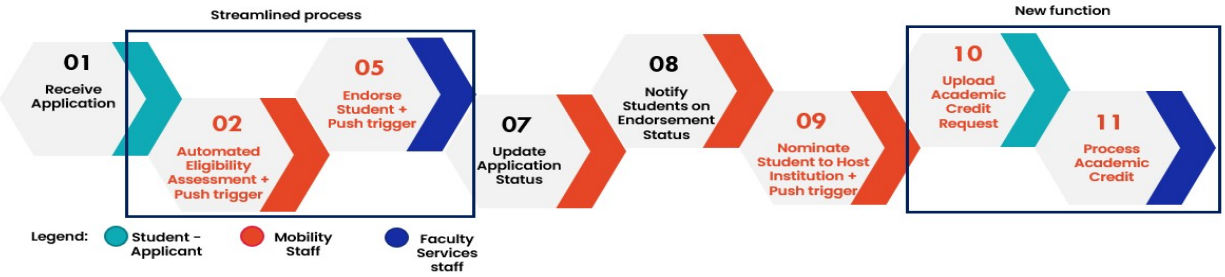

Figure 5: High-level study abroad process after process improvement

Process	Process Improvement	Improved Process?	Value Added Activity: Staff	Reduced Manhour	Cycle Time: Before	Cycle Time: After
01	No change	No	No		0	0
02	Automated – RPA	Yes	Yes	2.5 mins	3.0 mins	0.5 mins
03	Decommission	Yes	No	3.5 mins	3.5 mins	0
04	Decommission	Yes	No	3.0 mins	3.0 mins	0
05	Integrated – ETL	Yes	Yes	2.5 mins	6.5 mins	4.0 mins
06	Decommission	Yes	No	5.0 mins	5.0 mins	0
07	No change	No	No		3.0 mins	3.0 mins
08	No change	No	Yes		5.0 mins	5.0 mins
09	Integrated – ETL	Yes	Yes	3.5 mins	5.0 mins	1.5 mins
10	New function	Yes	Yes		-	-
11	New Function	Yes	Yes		-	-

Table 2. Process improvement overview

In addition to reduced staff hours, there are also intangible benefits for both staff and students such as: [1] timely processing of academic approval, [2] improved quality of reply to student enquiries, [3] circumventing unnecessary student enquiries and [4] a seamless end to end study abroad student experience. Further process analysis using an industry standard framework will be presented next.

6.2 Process Efficiency Analysis

The process improvement initiative proves to be effective as reflected in Figure 6, indicating reduced staff hours after process automation and application integration. In the six-sigma framework, one of the measures applied to understand the process performance is through process cycle efficiency (Montgomery and Woodall, 2008) as indicated below:

Process cycle efficiency = Value – Add Time / Process Cycle time

Applying the process cycle efficiency formula (to the data in Table 2), before process improvement is 57%, compared to 79% after process automation, indicating a 22% increase in efficiency. In addition, the total staff hours reduced based on an actual application received, is summarized in Figure 6, regardless of if the student withdrew the application to study overseas prior to departure.

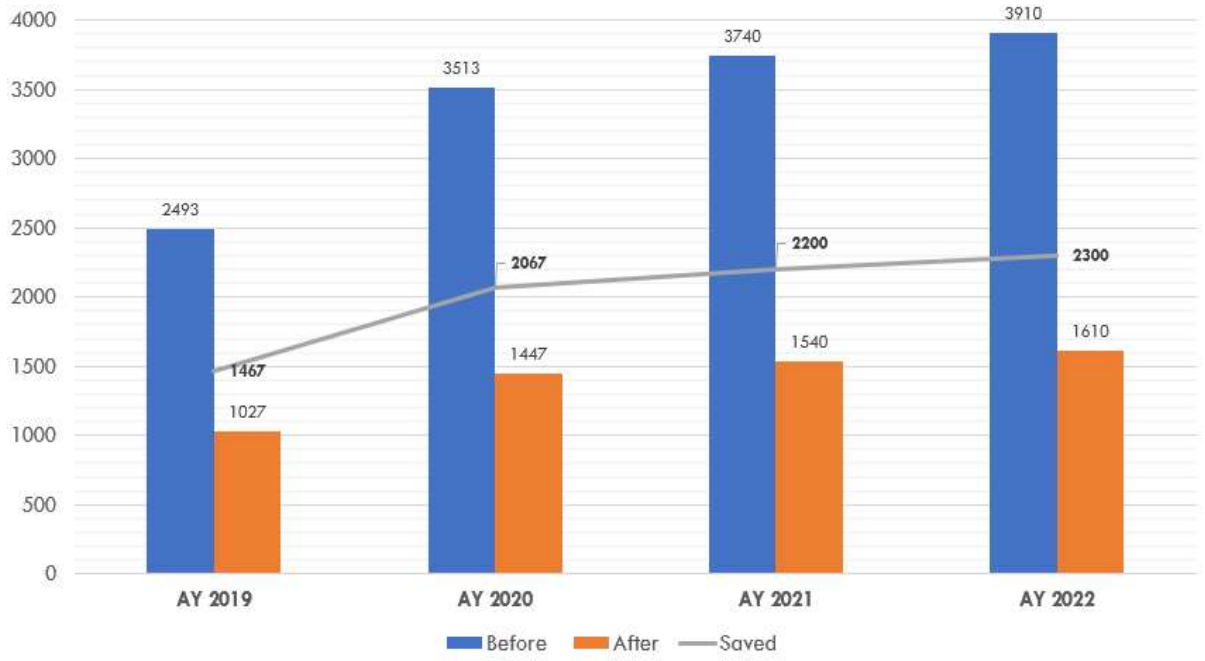

Figure 6: Estimate manhours before and after process automation

Study abroad applications are constantly increasing, even during Covid-19. In person programs were replaced by virtual programs, so benefits are still realized after its implementation. Next discussion is the perspective on RPA implantation and some of the industry-based implementation.

6.3 Robotic Process Automation Literature Review

The research on CSFs and inhibitors of RPA is limited. The search criteria focused on process automation, using a hermeneutic framework on the basket of 8 journals from 2016-2022. The initial keyword used was "process automation" and "higher education". Results did not achieve what we wished with limited literature, so instead the keyword was changed to "RPA" where 136 papers resulted. Reading through these papers, the objective was to understand the evolving landscape of RPA and different industry applications to capture CSFs and inhibitors of RPA implementation. After reading through the documents there were three sources fitting the search criteria. Chugh *et al.*'s (2021) narrative revolves around RPA, but the focus is on white papers and reports of organizations published from 2015-2020. The industry perspective on the challenges and benefits including how it is perceived is distinctly discussed. It is clear the monetary value of RPA implementation is the apparent goal, since productivity, efficiency, scalability, and consistency bring long-term organizational benefits. However, as RPA is still considered new technology, decision-makers in the organization still have insufficient understanding, potentially leading to unclear expectations or poor decisions that can affect top management buy in.

The next reference was a pragmatic application of RPA in payroll management (Hallikainen *et al.*, 2018), with the aim to streamline large-scale tasks of a business process outsourcing (BPO) provider based in Helsinki, Finland with an estimated 600 million transactions executed manually. A process improvement initiative started internally for 2 years but expanded the business to external customers because of the positive outcome within the company. Noting the company focused on developing subject matter experts first before identifying target processes, as well as the active engagement and collaboration of the project sponsor and program manager.

The final source discussed the adoption of RPA to improve business value at one of the largest mobile telecom providers in the UK, by deploying 160 robots to perform 500,000 processes every month with a yield ranging from 650% - 800% (Lacity *et al.*, 2016) within three years of investment. This vision was conceptualized by the CEO to reduce the cost of non-value adding activities, while optimising the process despite the pushback. Then a proof of concept developed to pilot 2 projects, extensive training with the provider is one of the activities prior to selection of the target process. A common trend in organizations adopting RPA is the strategic approach to increase value of the business, a vision on the ideal state to achieve its goals, along with provision of training to staff, and involvement of heads in the project while collaborating actively to other areas in organization. These challenges and approaches are also similar in study abroad process improvement initiatives. Using the process improvement in the study abroad and the literature reviews, a BPM capability framework is conceptualized to understand how RPA applications were considered a success.

6.4 BPM Capability Framework Analysis

Process automation and integration development involves several stakeholders in the university and is a collaborative initiative. The project team are typically composed of subject matter experts, a project manager, a developer, and users for testing. For the application integration, involved were the business sponsor, project managers, IT project managers, consultants, subject matter experts, test leads, organizational readiness personnel, and developers. The initial target capability areas identified in the BPM capability framework (Bruin and Rosemann, 2007) and evaluation of these capabilities are indicated in Table 4, where each capability is rated from 1-5, with 1 as lowest and 5 as highest capability.

Factors	Capability Areas	Study Abroad Case	Literature 1	Literature 2	Literature 3
Strategic Alignment	Process Context Management	5	5	5	5
	Advanced Process Automation	4	3	4	4
	Agile Process Improvement	4	4	5	5
Governance	Contextual BPM	5	4	4	5
	Process Architecture	4	4	4	4
	Roles and Responsibilities	3	4	4	5
Methods / IT	Process Context Management	5	4	4	4
	Advanced Process Automation	4	4	4	4
	Agile Process Improvement	4	4	4	4
People	Process Literacy	5	5	5	5
	Innovation Literacy	4	4	4	5
	Digital Literacy	4	3	3	4
Culture	Change centricity	4	4	4	4
	Process centricity	4	4	4	5
	Customer centricity	3	3	3	3

Table 4. BPM Capability Framework mapping of study abroad initiative and literature

The insights from Table 4 are that the top 3 factors with highest capability are: strategic alignment, people and governance and in capability areas are process context management, process literacy and contextual BPM. These capability areas reflect consistently on approaches indicated in the literature

review, reinforcing the significance of these factors. To further guide organizations in process automation initiative, a theoretical framework will be presented next.

6.5 Theoretical framework of success factors and inhibitors

The development of theoretical framework in Figure 7 is derived from the data collated across this research with the details of a study abroad application and the literature reviews discussed. This is a high-level generic framework designed for process automation programs, projects or initiatives. The theoretical framework represented in Figure 7 summarizes the concept of success factors and inhibitors.

The theoretical framework has 3V's as layered pillars - namely vision, volition and value. There are also CSFs and inhibitors influencing these pillars which is indicated in the right and left of each pillar. The peak is vision where the future state is defined. Volition is where the objective including the appetite of the organization. Value is where the motivations are laid.

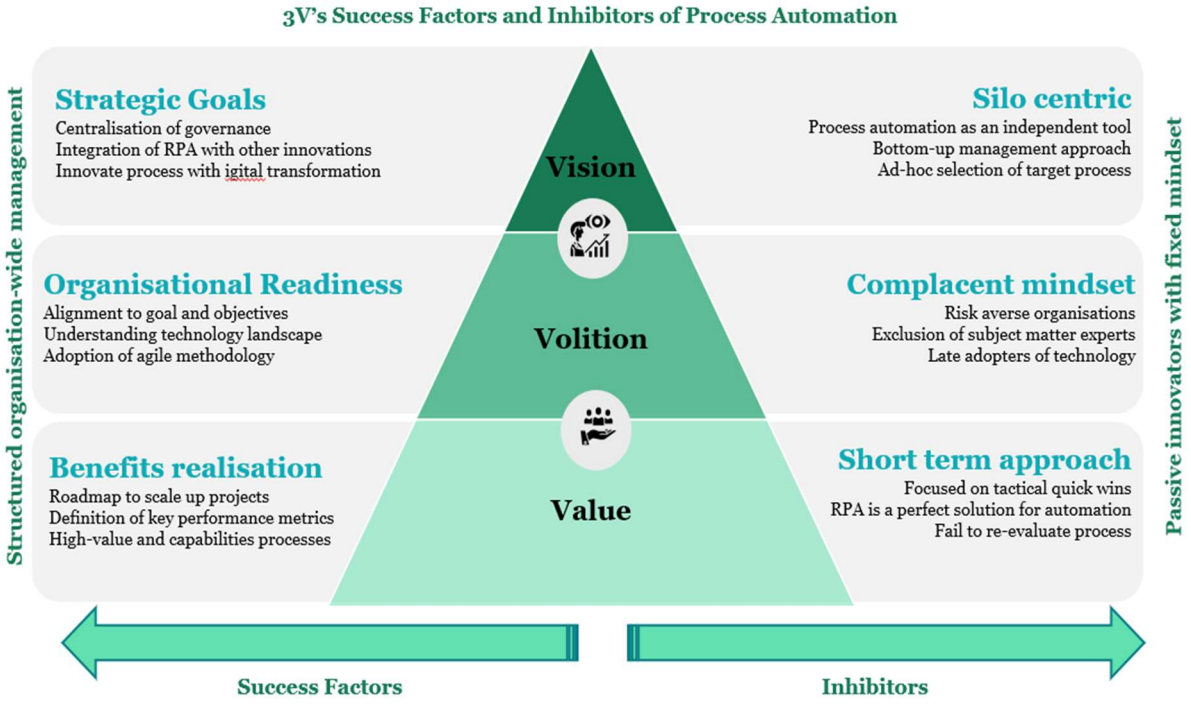

Figure 7: Theoretical framework

Vision is where organizations wish to be in future and where the strategic goal (Lacity *et al.*, 2016) is aligned to be successful, holistically looking at the entire organization and setting direction. While a siloed-centric mentality is focused on individual units and does not collaborate, which can deter progress because of a tunnel outlook. Volition is setting a purpose driven initiative that operationalises the vision, as people play an important role in this layer organizational preparedness should be considered. The training needed by staff (Hallikainen *et al.*, 2018) was identified, which clearly opposes to the complacent mindset that inhibits success when the organization is risk averse. Finally, the foundation of the pillar is value, rooted from the motivation of the initiative and where clear key performance indicators are set, as per study abroad the value is to improve the student experience which should have the ability to be self-sustaining, rather than focusing on upfront quick wins. With this theoretical framework, organizations will be guided on how to approach process automation initiatives.

7 Conclusion and Future Work

Business process management shows that it is an evolving paradigm (Seethamraju, 2010). Timing links re-engineering processes and information systems (Feller and Bentley, 2001), as efforts of redesigning core businesses must align to organizational vision, as the focus from silo-centric infrastructure shifts into an integrated customer-centric landscape. The theoretical framework presented was designed to be simple and easy to follow; it can serve as a checklist to increase success of process improvement initiatives. In this paper, we reported a detailed analysis of the CSFs influencing a process aiming to pivot on more value adding activities while increasing job satisfaction. For future work, expanding the

research area to other process improvement initiatives driving innovation with the establishment of key performance metrics guidelines, that include more than financial analysis for RPA.

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