Journal of Construction Project Management and Innovation, 10 (1): 86-99, 2020
ISSN 2223-7852

DOI: https://doi.org/10.36615/jcpmi.v10i1.342

A SOFT SYSTEMS METHODOLOGY APPROACH TO IMPROVING THE SUPPLY CHAIN OF A CONSTRUCTION PROJECT IN GAUTENG PROVINCE, SOUTH AFRICA

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ABSTRACT

The Soft Systems Methodology (SSM) was developed as a set of tools for identifying and making incremental steps to improve situations with poorly defined causes or solutions. The supply chain forms a key process of any construction project; however, on any given construction site, supply chain inefficiencies could arise from many different avenues. Opinions vary, though, on which of these avenues is more important for increasing supply chain efficiencies; whether any problem even exist across the different aspects of the supply chain; as well as what steps should be taken to resolve them. It was therefore studied, here, whether SSM could be employed as a useful tool to systematically apply in the supply chains of a construction project in South Africa, for understanding and targeting the problematic situations that arise. Following thorough cyclical open-ended interviews with 17 workers, supervisors, foremen, site clerks, senior managers, and the CEO of the principal contractor at a new office park construction project in Rosebank, Johannesburg, and a thematic analysis of the data, SSM was performed to understand the existing challenges, and develop a suitable model for improvement. The study found that SSM was a good tool for understanding the 'messy' circumstances surrounding the chosen construction project supply chain, as well as actions that could be taken to improve the supply chain's efficiency on site. The findings add weight to the argument that SSM could be a good tool for project managers to systematically introduce into their project planning regimens.

Keywords: Soft Systems Methodology (SSM); supply chain; construction projects; project management.

1. INTRODUCTION

Large numbers of people are employed at any given time on construction projects (Ball, 2014), and many peculiarities affect the complexities and life spans of these projects. The influence of project managers, when leading projects, relies on their capacities to drive and direct the various sections of their projects, through their leadership acumen (Lloyd-Walker and Walker, 2011). Being a leader in a complicated world is frequently observed from the view of systems thinking, where the literature argues that an integral relationship exists between leadership performance and systems thinking (Palaima and Skaržauskienė, 2010).

Systems thinking is embodied in the notion that sequences of related events can be devised to target smaller entities, which together, combine to form a larger entity (Wilson and Van Haperen, 2015). A process of systems thinking that has been introduced and developed for solving management problems, in the past four decades, is the Soft Systems

Methodology (SSM). Originally devised by Checkland and Scholes (1999; 2001) and Wilson (1990; 2001), following a systematic progression of action research, the methodology was devised for resolving various types of problematic, or "messy situations".

Offering a set of tools for identifying and incrementally making steps to improve poorly defined or "soft" problems (Checkland and Poulter, 2010:191), SSM was created to help clarify and target issues that may be difficult to grasp, due to, for instance, the political or interpersonal factors surrounding these issues (Kayaga, 2008). Situations where SSM is well suited include those that are hard to define, continuously changing, and socially complex, while being composed of numerous interrelated associations that have unforeseen endings and no clear solutions (Proches and Bodhanya, 2015). Settings characterised by soft problems are in contrast to those with "hard" problems, which can instead be more clearly defined, and often present with more obvious solutions (Brenton, 2007:12). SSM is therefore of significant value when investigating complicated situations where no single opinion exists on what the root cause of the problem is, nor what actions should be implemented to resolve that situation (Checkland and Scholes, 1999; Wilson, 1990; 2001).

SSM is a process of action-oriented inquiry into problematic situations, where individuals learn what to do by understanding the circumstances, and therein making efforts to resolve them (Checkland and Poulter, 2010). On any given construction site, problems in the supply chain could surface from one of the two main directions; where issues could arise either from the supply chain itself, such as from the reliability of the materials deliveries, or from the supply chain processes, such as through information sharing (Thunberg et al., 2017). Attitudes vary, though, regarding which of these two directions is more important for increasing a project's supply chain; whether any problems even exist across the different aspects of the supply chain; as well as what steps should be taken to resolve these issues. Yet with the supply chain forming a key element of any construction project, any problems therein can have enormous knock-on effects across the entire project.

It was therefore proposed, here, that SSM could be a useful tool to apply systematically in the supply chain of a construction project in South Africa, for understanding and targeting any problematic situations arising; for determining the issues that have hindered the performances of the project's supply chain; and to offer actions to help minimise these challenges. To the researcher's knowledge, only one study has been performed to apply SSM for the analysis of problems surrounding the construction supply chain; in which Elliman and Orange (2000) performed an SSM-based study two decades ago on the supply chain of a construction project in the United Kingdom. That study, though, is now both outdated and unreflective of the current construction industry in South Africa.

Furthermore, a systematic literature search on Google Scholar, to assess the broad spectrum of literature published until 2019, found no studies using SSM to observe the supply chain of South African construction projects — making this study the first of its kind in South Africa. Recent research by Mello et al. (2017) applied a soft systems methodology to reflect on the improvement of engineer-to-order supply chains; however, that study was neither based in South Africa, nor on the construction industry. Panova and Hilletofth (2018) contemplated how to target and resolve risks and delays in the supply chain of a construction project; and although they used a systems thinking approach, they did not specifically apply SSM.

Indeed, studies on the supply chain of the construction industry, overall, are sparse, with limited studies such as by Ojo et al. (2014) and Ibem and Laryea (2015) considering the factors preventing green sustainable supply chain management in Nigeria, and electronic procurement and e-commerce in South Africa's construction supply chain, respectively. Neither of these studies, though, considered using an SSM approach.

This research was therefore aimed at comprehending the ability of SSM to function as a systematic tool in understanding and targeting problematic situations arising around the human capital and leadership elements of the supply chain of an office park construction project in Johannesburg. The intention was to determine whether a model could be formulated, via SSM, to optimise the supply chain's effectiveness. This was established on the philosophy that project management is a rapidly changing terrain, and requires the complexity of projects to be reviewed through a soft systems thinking lens.

2. MATERIALS AND METHODS

This study was designed as a qualitative study, in line with the research philosophy of action research, as expressed through the ideologies of SSM. This was done to identify the issues and potential improvements that could be made to the supply chain of a new office park construction project in Rosebank, Johannesburg. A descriptive research framework was used, with procedures being followed to align with the SSM.

2.1 Target population

The target population of this study was principal contractors, subcontractors, project managers, foremen, and different levels of management at various companies operating on a new office park in Rosebank, Johannesburg. This office park was selected by convenience, due to its direct prior connection to the researcher. A purposive sample of 17 participants was formulated for this study, which included members of the construction project that were known to have interacted with the project's supply chain; such as workers, supervisors, foremen, site clerks, senior managers, and the CEO of the principal contractor.

2.2 Research instrument and data collection procedures

Interviews with open-ended questions, and audio recording devices were used to gather the data for the study; while the interviews were designed with questions relating to various 'soft' issues, such as trust, reliability, and care. To gather the data, the open-ended questions were asked during one-on-one, private interviews with the participants. Voice-recording equipment was used to capture the interview data, which was then transcribed into written text in Microsoft Word format, for data analysis.

2.3 Data analysis

The data analysis was separated into two stages; where, in Stage One, the transcribed recordings of the interviews were firstly analysed using standard methods of qualitative thematic analysis, as per the directions of Braun and Clarke (2006), Vaismoradi et al. (2013), and Vaismoradi et al. (2016). The thematic analysis enabled the researcher to detect patterns of ideas within the data; to create and record the detailed lists of codes describing the patterns within the data; and to explore for themes across the patterns of codes. In Stage Two, the focus was on performing an SSM on the data; however, while the thematic analysis and SSM were conducted as two distinct phases, their overall end goals and purpose were the same. The two phases were, consequently, mutually complementary and integrally linked, as outlined next.

2.3.1 Soft systems methodology

For the second stage of the data analysis, SSM was performed according to the directions of Williams (2005), and Burge (2015). The following seven key steps of SSM were followed:

- **Step One:** Delving into the problematic situation to garner all prevailing viewpoints and information surrounding the situation's circumstances. This was performed through a review of the data from the thematic analysis in Stage One.
- **Step Two:** Using rich pictures to express the problematic situation and all its associated relationships.
- **Step Three:** Defining the overarching systems of purposeful behaviour to improve the situation — the 'root definitions' — together with the communications, emergent

properties, hierarchies and controls necessary to target the problematic situation. The root definitions should define how the real world is, currently, and what transformation processes could be introduced to achieve a good ("unproblematic") situation (Brenton, 2007:13). A technique referred to as 'CATWOE' is often proposed, to define the **c**ustomers, **a**ctors, **t**ransformation processes, **w**orldviews, **o**wners, and **e**nvironmental constraints (Checkland and Poulter, 2006); and this study used a CATWOE technique to express root definitions for system 'X', to accomplish 'Y', for stakeholder 'Z".

- **Step Four:** Constructing conceptual models for each root definition. Conceptual models are graphical, visual roadmaps comprising between five and nine feasible activities, in flow charts of interconnected tasks, which can be performed to achieve the root definitions. Tasks were selected, here, to satisfy a 'three-E's' guideline of being the most **e**fficient tasks, with the highest **e**fficacy, and the potential for being the most **e**ffective.
- **Step Five:** Measuring the conceptual models in relation to real world situations; so that the different action-based models are compared and assessed for their practical feasibilities. This step was built into the interviews, where a discussion was initiated to allow the respondents to express which changes they thought would be accepted; and if not, what internal or external factors were limiting them from being implemented.
- **Step Six:** Identifying potential and practicable changes that could be made, through an iterative, cyclical process of brainstorming and free thinking, which considers what changes could be made to the tasks in the conceptual model, so that they are more likely to be successfully implemented. In the interviews, this step was performed by iteratively considering the difficulties that would limit the ideal changes from being made, and what could otherwise be done to avoid or bypass these difficulties. To do so, the tasks of the conceptual model were placed on an ease-benefit matrix, so that the ease of the tasks was measured relative to the potential benefit they would have in improving the problematic situation (Burge, 2015).
- **Step Seven:** Taking action to implement the plan for improvement. This is more of an iterative process of trial-and-error, and cyclical improvement through a reciprocal repetition of the SSM steps three-to-six. This step was not ultimately performed for the purposes of this study, though, since the purpose of the study was to identify the existing challenges of the supply chain of the selected construction project and develop a suitable model for change, as opposed to actually implementing these changes.

2.4 Important considerations of the methodology

It is important to emphasise that the seven steps of the SSM were merged into the study's methodology by structuring the interview questions appropriately, and processing and analysing the data in a manner that the above SSM steps were accomplished. In addition, contrary to the more stringent approaches of hard systems methodologies, SSM is a more flexible tool that allows the investigator to customise the research framework to suit the situation in question (Hildbrand and Bodhanya, 2014). In the research setting of the construction project, here, a structured interview process with individual participants was also deemed to be far more feasible than attempting to gather all the participants together for group debates, iterative analyses and follow-up discussions. This is because there was a large variety of companies and job titles on the site, which were to be assessed. In addition, the dynamic nature of the project meant that multiple follow-up interviews and focus groups with gatherings of the same participants would have been very difficult to achieve, while potentially obstructing the workflow of the project.

2.4.1 Reliability, validity and the elimination of bias

Internal consistency and interrater reliability were enhanced while codifying the interview data, and professional data analysts were contracted to maximise the consistency of the outcomes, while minimising researcher biases. The construct and content validity were enhanced during the design of the study, by incorporating and allowing a complete spectrum of soft issues to be interrogated; while criterion validity was ensured when triangulating the results of this study with the literature. Interviews were held anonymously and in private to overcome inconsistency, poor information sharing, and unreliability; while encouraging truthfulness and openness among the participants.

3. RESULTS

The results of this study are outlined according to the findings of each step of the SSM methodology.

3.1 Step One: Delving into the problematic situation

The problematic situation was considered and observed during the interviews and subsequent thematic analysis, where the issues that were operating poorly, and the systems that were functioning well, were both determined and considered. Aspects of the supply chain that were claimed to have been functioning well on the project, as observed by a consensus among different respondents, was with the scheduling of the equipment and the materials on site. The safety on site, together with the supply delivery matters, and materials and equipment handling were noted recurrently on three occasions, each, by the respondents; and storing and procurement were noted by two participants, each, to have been working well. It is worth clarifying that although this study was qualitative, and therefore inherently devoid of numerical counting, multiple occurrences of a theme or topic in the interviews was reasoned to indicate an element of consensus, without necessarily confirming a greater degree of importance.

Delving deeper into the supply chain management's soft elements, respondents argued that the trust, emotional intelligence, risk-taking and vision of the project management had enhanced the working environment, worker skills, project efficiency, and teamwork on the project; together with improvements that were specific to each manager in question. In addition, the motivation of the project managers to the workers and subcontractors, and their communication, supportiveness, and self-awareness had resulted in a good information flow; supplying the necessary information; explaining challenges and tasks well; holding daily and weekly meetings; having multiple discussions on site; promoting work reminders; and improving subcontractor-manager meetings.

3.2 Step Two: Expressing the situation of the problem

The situation of the problem, as deciphered from the thematic analysis of the interview transcripts, was presented in the form of a rich picture, where the core problematic issues were listed in the centre cloud of the picture. As shown in Figure 1 there were 73 subthemes of issues highlighted across the project's supply chain. These could be categorised into 11 overarching problematic areas of the project's supply chain, which pertained to the site's management, site operation and efficiency, safety, space, the site's location, materials supply, security, client and time-related issues, site information, communication, and worker-related issues. In the case of 'security problems', for instance, the respondents had noted six themes of issues during the interviews, where problems were said to have occurred due to site break-ins, materials theft, equipment theft, tool theft, and tool forging.

While some of the topics in the rich picture, were populated with more extensive lists of issues, such as site-management problems, and worker-related problems, where 15 and 11 issues were observed, respectively, some overarching themes were only noted to have been plagued by three, or even fewer issues. The problem of site information, for instance, was said to have had issues with the wrong information being given, inconvenient design changes, and plans being given late; while in the case of site location problems, issues with poor site access, the inconvenient site location, and the site being unreachable, were highlighted during the interviews. In the case of safety problems, a single sub-theme of poor work safety values, was noted to have hampering the smooth operation of the project's supply chain.

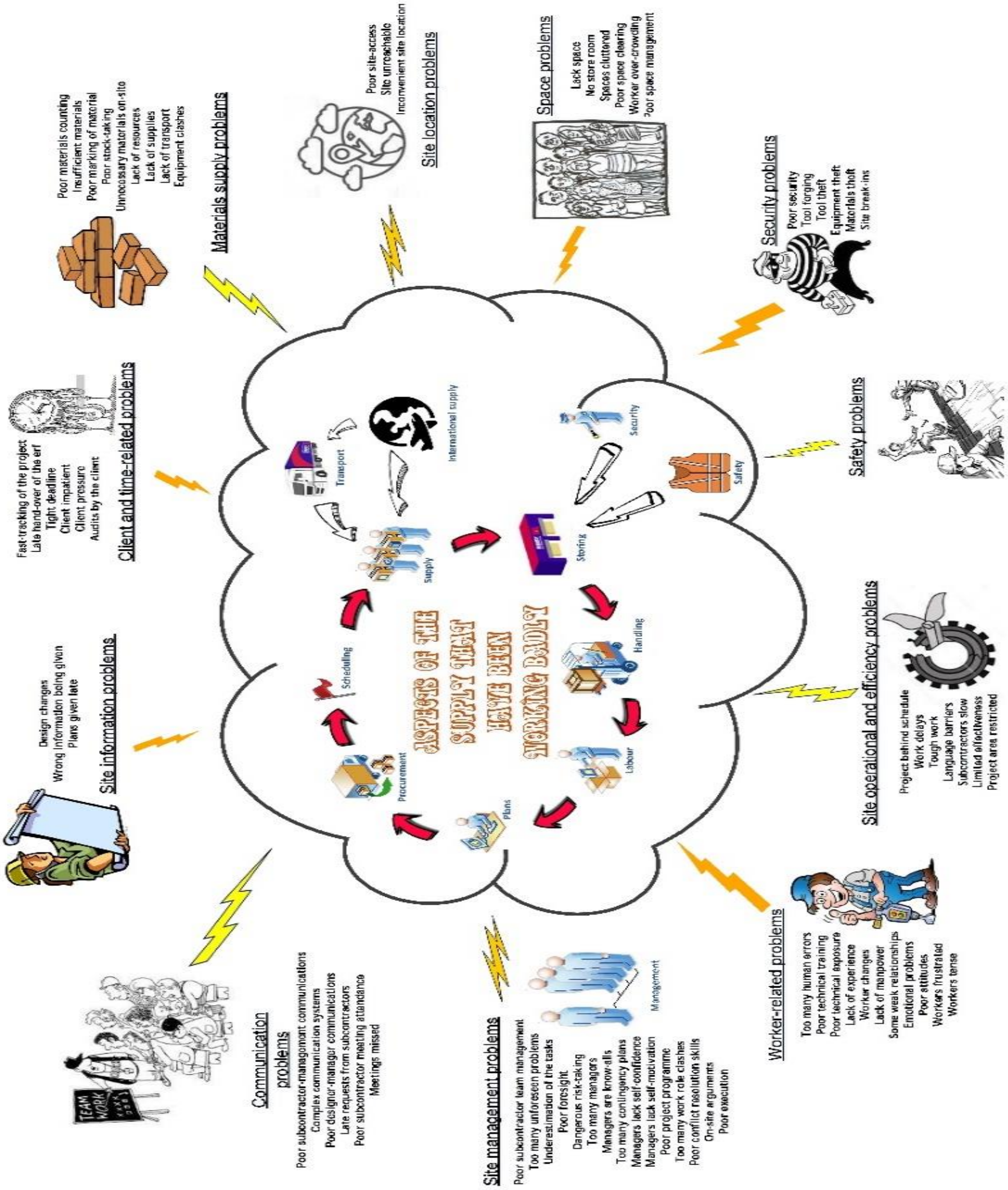

Figure1: Rich picture depicting the supply chain problems, and their associations

Since the entire focus of SSM is not specifically on the issues, though, but on the steps for improvement, each of the 11 overarching categories of problematic issues will not be re-listed from the rich picture, here. Instead, it is worth emphasizing that the rich picture formed the basis upon which to formulate the root definitions, as presented next.

3.3 Step Three: Formulating root definitions

While 11 overarching categories of problem areas were deciphered and listed in the rich picture, the third step of SSM, and particularly its CATWOE analysis, defined only five root definitions, or systems of purposeful behaviour to target the problematic situations. This is because certain of the actions for improvement could be clustered together to resolve the issues of several problematic areas at once. The five root definitions that were formulated, in X-Y-Z format (see Checkland and Scholes, 2001), were:

- To apply some adjustments to the operational, efficiency and space systems on site (X) by workers, subcontractors and project managers (Y), to target the operational, efficiency and space-related problems experienced (Z).
- To introduce numerous new systems of site information and communication (X) by the workers, subcontractors, designers and project managers (Y), to target the site information and communication issues that were being experienced (Z).
- To make changes to some of the time, client, and site management-related systems on the site (X) by the team leaders, foremen and project managers (Y), to target the time, client, and site management-related problems experienced (Z).
- To apply some adjustments to the materials' supply and project planning mechanisms of the site (X) by the project's managers (Y), to target the materials' supply and project planning problems experienced (Z).
- To make adjustments to the training, skills, security and safety systems on the site (X) by the workers, subcontractors and project managers (Y), to target the training, skills, security and safety problems experienced (Z).

3.4 Step Four: Constructing conceptual models

Upon analysis of the interview transcript data, the answers of the respondents regarding potential solutions to the aforementioned problems, allowed conceptual models to be created. These conceptual models were flow charts of between five and nine interconnected, feasible actions to perform, to achieve the five root definitions from Step Three. The conceptual model of steps for targeting the first root definition, for instance, and attempting to resolve the operational, efficiency and space-related problems, is presented in Figure 2.

A plan of four separate lines of sequentially executed tasks was proposed to target the operational, efficiency and space-related problems, where it was proposed that more workers should be employed on site; and that bonuses should be paid to incentivise the workers to improve work performance. A concurrent set of proposed tasks was for the workers to be supplied with improved worker transport, which was argued to improve the workers' cooperation. Concurrently, it was proposed that payments to the subcontractors should be withheld until they had completed their work, which would improve the operational efficiency of the subcontractors. To address the space-related issues on site, it was proposed that space from the adjoining properties should be rented for use on this project; and for the workers to be provided with alternative eating areas. In addition, it was recommended that the project's management should procure additional equipment to improve the operational efficiency of the site.

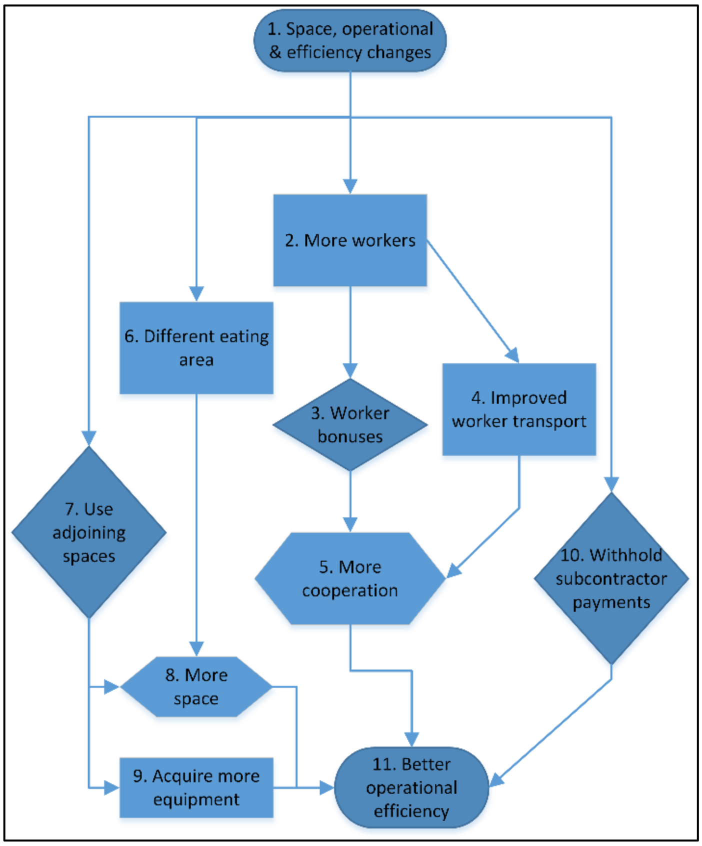

Figure 2: Conceptual model of the tasks that could be performed to target the operational, efficiency and space-related problems on site

Similar flows charts of tasks were produced for each of the other four conceptual models as well; where constructing these conceptual models formed a central component of the SSM. The five intricate flow charts that were produced are too lengthy and detailed to list in their entirety, here. It is also worth noting that an ease-benefit matrix was compiled, in SSM Steps Five and Six, to highlight which of the steps would be the most feasible to perform, and with the most benefit — and these results are presented in more detail later in the results.

3.5 Step Five: Measuring the conceptual models against real world situations

When comparing the conceptual models, above, to real world situations, discussions were initiated with the respondents during the same interviews, to assess the likelihood that their recommended tasks would be accepted or implemented by the project management; and what could act to hamper these tasks from succeeding. General pessimism was expressed by seven respondents, who thought that their suggestions would likely not be considered or implemented by the management; while two respondents stated that there was some chance that the conceptual models would be implemented, if certain concessions or compromises were made.

A lower number of six respondents were optimistic that the recommendations used to formulate the conceptual models would be considered and implemented by the project's management; though they conceded that numerous uncontrollable internal and external factors did still need to be overcome, for the conceptual models to succeed. The uncontrollable factors that were said to be hampering the successful implementation of the conceptual models could be categorised into five broad themes, as follows:

- Traffic limitations: Poor road conditions; high traffic; site on a public road; and deliveries made in opposing traffic.
- Financial limitations: Lack of capital/funds.
- Community limitations: Intimidation by the community; community complaints; and grumpy neighbours.
- Time limitations: A shortage of time; and an immovable project deadline.
- Natural limitations: Rain delays.

3.6 Step Six: Identifying possible and feasible changes

In line with the iterative, cyclical nature of SSM, questions were asked to determine what feasible and possible changes could be made to help overcome the uncontrollable factors noted previously. Only seven respondents were forthcoming with any additional ripostes in the interviews, with the following five themes of new changes being proposed:

- Communication changes: Increasing the frequency of mutual discussions; and increasing communications on site.
- Client and time-related changes: Having workers working over-time to finish in time; negotiating a later project hand-over date.
- Site operations and efficiency changes: Increasing equipment efficiency.
- Site management changes: Reducing the project's management autonomy.
- Space changes: Recycling space on site.

3.7 Step Seven: Taking action to resolve the problematic issues

While the final step of SSM is typically to take action to resolve the problematic issues, this was not done for this study. This is because the purpose was only to observe the efficacy of SSM in defining and developing a model to target the existing challenges of the project's supply chain. Instead, a model for change was developed by placing all of the recommendations from the SSM Steps Four – to – Six into an ease-benefit matrix, as shown in Figure 3.

Actions listed in the upper-right hand quadrant of the matrix were those that were considered to have the greatest potential benefit to the project, while requiring the least effort. Conversely, actions listed in the lower-left hand quadrant of the matrix were considered to have the least potential benefit to the project, while requiring the most effort. Changes that were recommended by the respondents, but which were deemed by the researcher to be more difficult to implement, and/or had lower potential benefits to the project, were placed in the other quadrants of the matrix.

Actions noted in red were those that were specifically listed by the respondents in Step Six, above. These were also placed in the upper right-hand quadrant of the matrix. Another five recommendations from Steps Four and Five of the SSM were also deemed to be worthy, by the researcher, of being included in the upper-right quadrant of the matrix, as noted in black. These were for the project managers to ensure work understanding on site; to provide earlier communications on delivery; to perform more forward planning; to ensure work adherence; and to check work quality.

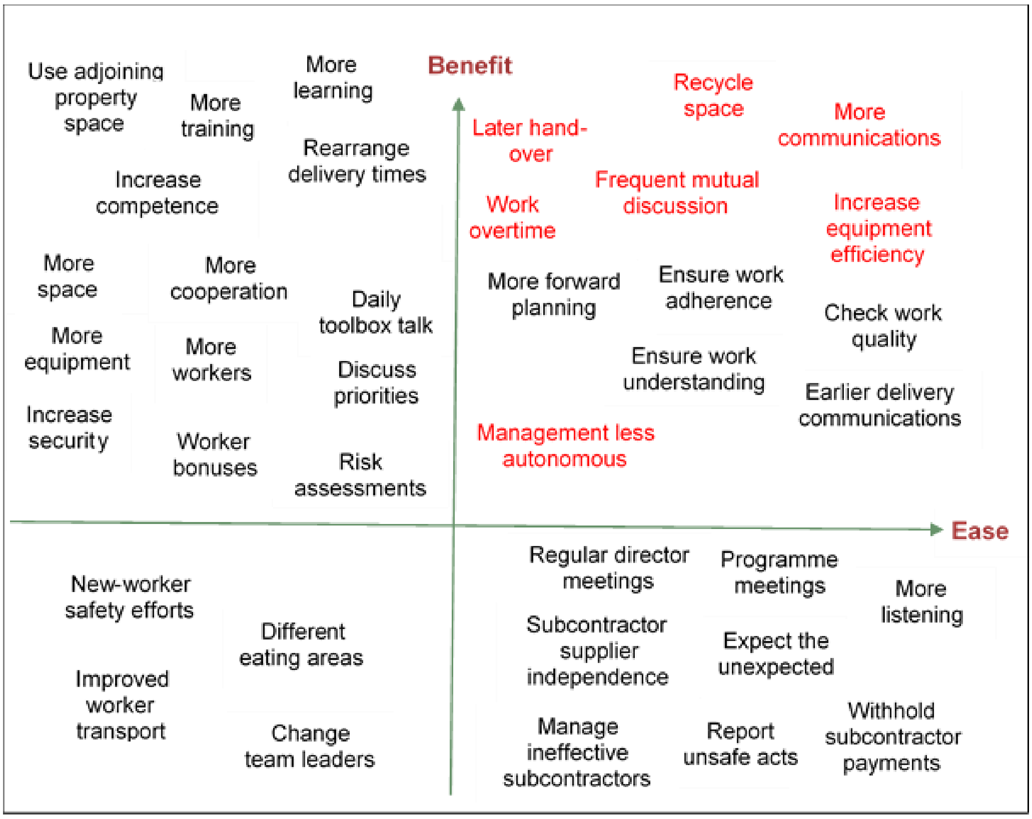

Figure 3: An ease-benefit matrix depicting the model for change to improve the supply chain of the selected construction project

4. DISCUSSION

The goal of SSM is to explore problematic situations, where the problems are either likely to have been poorly defined; or where the actions for improvement may be either not known or debated among the key stakeholders. The literature is clear that the smooth operation of supply chains is under constant threat of issues caused by internal challenges, which occur on a more focused, site-specific scale, or external challenges that occur on a broader, macro-scale (Yüksel, 2012; Vrijhoef and Koskela, 2000).

It was therefore no surprise that this study exposed a broad spectrum of internal and external issues that were hampering both the smooth operation of the project supply chain, and any potential efforts to improve it. It was an interesting finding of this study, too, that in accordance with the SSM ideology, many of the weaknesses in the supply chain appeared to be in direct contrast to the strengths that had been noted; or that, while some people lauded some sections of the supply chain as having strengths, others discredited these same sections for their weaknesses. This appeared to support the notion that, in line with a fundamental principle of SSM, the definition of a problematic situation is often unclearly defined, and there is often a lack of agreement over whether a problem even exists in the first place (Proches and Bodhanya, 2015).

For instance, a primary example of the 'messiness' of the issues surrounding this project's supply chain was demonstrated wherein the safety, storing, procurement, scheduling and handling aspects of the supply chain were claimed to have been working well. However, a large proportion of the respondents similarly noted that these areas of the project were also functioning poorly. In fact, in each section in which aspects were said to have been working well, other respondents made claims that they were working poorly. While it is not unreasonable to consider that even within the same departments or sections, certain aspects may have been working well, while others may not, and that the codification during the thematic analysis may have made the issues appear contradictory, it did emphasise the need for each step of the SSM to be completed thoroughly. This was done to delineate the issues clearly and unambiguously, during the remaining steps of SSM.

Next, it is valuable to note that the setbacks experienced in this project's supply chain were not specific or unique to this project, and various claims of what was occurring on this construction site, appeared to have been echoed in the literature as well. Problems in many projects, for instance, are known to arise when attempting to reach tight, or unrealistic schedules; as a result of non- or delayed payment by financiers; from poor planning and lack of experience and/or skills; and due to insufficient manpower on the workforce (Islam Mohammad Saiful, 2015). Poor scheduling and planning are known to cause issues, for instance, due to the poor involvement of the different stakeholders, from a project's onset (Bankvall et al., 2010). Poor planning is a significant cause for increased penalties and costs (Subramani et al., 2014), while it also drives projects to deteriorate over time, as subcontractors and primary contractors scramble for resources to complete their works (Kerzner and Kerzner, 2017). Issues such as this were echoed on this project as well.

It is similarly important to note that numerous potential issues listed in the literature were not specifically noted to have caused any problems in this study. The literature describes, for instance, that problems can be caused on construction sites due to nepotism and corruption (Aigbavboa et al., 2016; Le et al., 2014), and/or collusion (Bowen et al., 2007); though none of these issues were mentioned in this study. SSM therefore appeared to be valuable for evaluating the unique circumstances of this particular project's supply chain.

At the culmination of the seven steps of SSM, then, a model for improvement was devised, where changes were proposed that were deemed to potentially generate the most benefit, while requiring the least amount of resources, time, and effort. The steps to be taken were for space to be recycled, for equipment efficiency to be increased, to have the workers working over-time, and for a later hand-over time for the project to be negotiated. It was also recommended by the respondents, at the end of the cyclical questioning, for the management to be given less autonomy. It is worth noting, though, that removing the management's autonomy would likely cause numerous other, unforeseen problems, without presenting a clear benefit to the project. It was therefore placed lower down, in the centre of the ease-benefit matrix, instead of securely in its top right-hand corner.

In addition, various other recommended tasks were placed in the upper right-hand quadrant of the ease-benefit matrix, which had been noted during the first five steps of SSM, and which the researcher judged to be proportionally higher on the ease-benefit spectrum than the other recommended actions. These actions were for the project managers to check the work quality more, and to ensure that there was suitable work understanding on site; to provide earlier communications on deliveries; to perform more forward planning; and for the managers to ensure that there was suitable work adherence.

It is worth emphasizing that there was no clear guideline as to which actions would have greater or lesser benefit to the project, or which would be easier or more difficult to implement. These recommended actions were only placed on the ease-benefit matrix according to the researcher's initiative and intuition. This initiative was taken by pondering the overall benefit that the actions would likely have had on the project's supply chain, relative to the amount of time, resources and effort required. In fact, the final step of SSM is supposed to be undertaken to test the model of proposed actions, and to iteratively review their successes and/or failures, before generating new proposed actions to further improve the problematic situation. Due to the nature of this study, though, this could not be performed, and a simple model for improvement could only be proposed following an iterative, single-interview process.

In light of the amount of success that SSM appeared to have, though, in understanding the current situation, and in finding actions for improving the issues within the project's supply chain, it could be determined that the root definition and conceptual model that would most-likely succeed, upon initial trials, was for actions to be taken by the team leaders, foremen and project managers, to target the time, client, and site management-related problems experienced on site. This is because almost all of the actions on the flow-chart devised for this root definition could be placed highly on the ease-benefit matrix.

Furthermore, the root definition and conceptual model that would most likely produce the largest benefits for the project, was for proposed actions to be taken by the workers, subcontractors and project managers to target operational, efficiency and space systems problems on site. While these actions, according to the ease-benefit matrix, would have been more-challenging to achieve — being on the 'less-easy' end of the ease scale — by executing these actions, it could be logically reasoned that the project would see considerable tangible benefits. Furthermore, while executing the other three conceptual models would also render benefits to the project, in light of the relative positions of the majority of their actions on the ease-benefit matrix, they would likely have realised only a lower benefit to the supply chain, with proportionally higher effort than the above-mentioned two conceptual models.

5. CONCLUSION

The researcher can confidently conclude that SSM was a good tool for understanding the 'messy' circumstances surrounding the chosen construction project supply chain. SSM was useful for revealing some of the complexity within the project, how it was affecting the supply chain, and what actions could be taken to improve the supply chain's efficiency on site. These findings add weight to the argument that SSM could be a good tool for project managers to systematically introduce into their project planning regimens, so that the issues and challenges that are experienced on site can be targeted in a manner that is customised to the circumstances of the projects.

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